THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The Institution and the Electricity Supply Industry	569
The Diesel Oil Engine (*illustrated*)	571
The Card System applied to Central Electric Supply Stations (*illustrated*) (*concluded*)	572
Current Specifications.—LV.	574
Behr's Mono-Railway	574
Brake Power of Liverpool Electric Cars	575
Electricity in Mines	575
Reviews	576
Correspondence	577
The Rating of Electric Light and Power Stations (*continued*)	578
Legal	579
The Rosenthal Storage Battery (*illustrated*)	580
The Part played by the Antenna in Wireless Telegraphy ...	582
Business Notes	583
The Construction of an Electric Tramway Motor (*illustrated*) (*concluded*)	589
Supply Station Accounts	594
City Notes	595
Traffic Receipts	600
Stocks and Shares	600
Share List of Electrical Companies	601
Market Quotations	602
Metal Market.—Fluctuations in March	603
Institution of Electrical Engineers:— Some Notes on Polyphase Sub-station Machinery (*illus.*) (*continued*)	603
Electrical Mining Plant in Australia (*concluded*)	605
Institution of Electrical Engineers (Glasgow Section):— Notes on Some Systems of Laying Underground Cables	605
Underground Electric Railways	606
The Generation and Transmission of Electric Energy at and from Coal Pit Centres (*continued*)	607
The Testing of Electrical Plant	608
Some Notes on Changes of Periodicity	609
Bare Copper Mains and Burst Water Pipes (*illustrated*) ...	610
New Patents	611
Abstracts of Published Specifications	611

THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

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THE INSTITUTION AND THE ELECTRICITY SUPPLY INDUSTRY.

THE object of the Institution of Electrical Engineers is to promote the general advancement of electrical science and its applications. When we find the President of the Institution giving evidence in favour of a gas company, and against an electrical undertaking, it makes one wonder how he is promoting its objects.

On the 21st ult. a Committee of the House of Lords had before them a Bill promoted by the Sheffield Corporation in relation to extensions of their Electric Tramways. The Bill was opposed by the Sheffield United Gas Company, and their witnesses included Professor J. Perry, announced as President of the Institution of Electrical Engineers, and Professor Ayrton, one of the Past-Presidents, who thus were made to figure in support of a claim by a gas company to interfere seriously with an electrical undertaking.

The result was unfortunate, for the Committee of the House of Lords, probably influenced by the position of the two Professors in connection with the Institution, inserted a clause in the Bill which may cause endless litigation. The question raised was as to possible damage to the Gas Company's mains, pipes, or apparatus from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction on any of the tramways belonging to the Sheffield Corporation. If the professors had been engaged in proving the serious inconvenience to electricity supply undertakings and to the public—from leakage of gas mains—they would have been better employed.

The position of the Institution in relation to the electrical industry is by no means what it ought to be; and it may be useful to consider how they manage matters on the Continent, where much healthier conditions prevail.

Let us take Switzerland as an example of the proper organisation of the business, and compare it with the want of power and ability of our Institution of Electrical Engineers to watch over and promote the general advancement of the industry. In Switzerland, the Government and the Swiss Institution of Electrical Engineers (L'Association Suisse des Electriciens) work together, in close connection with all branches of the industry. The Government appoint a Standing Committee, the majority of whom are leading Swiss scientists and electrical engineers, assisted by commercial men.

This Committee is appointed for periods of three years; it advises the Government concerning legislation in electrical matters and on technical questions—keeping in close touch with the Institution of Electrical Engineers. It inspects all installations and reports on anything that appears to demand new regulations or alterations in the law. The Government

practically acts upon the advice of this Committee, issuing statutory laws in relation to electricity supply, as occasion requires. The Committee appoints a Technical Inspection Department (L'Inspectorat Technique) to supervise installations in most of the Cantons. This Inspection Department consists of electrical engineers selected from the Swiss Institution, and works hand-in-hand with the Government and the Institution, who jointly pay them.

The Swiss Institution especially watches over all developments taking place in electro-technical installations, and brings the matter before the Government when fresh legislation becomes necessary. The Institution issues a set of advisory rules for all kinds of installations, based on the Government regulations issued through the Standing Committee already referred to, and these rules are complied with by all undertakers of electricity supply.

Under this comprehensive and compact organisation, the electricity supply industry is developed under the best auspices, and it compares most favourably with the want of systematic management which prevails in our own country. These arrangements have been carried out since 1899, and a Bill is now passing through Parliament which will give further statutory powers to the organisation.

The Institution of Electrical Engineers in our own country exercises no influence over the Government, and although the Board of Trade occasionally institutes an inquiry on certain details—such as the question of the alteration in pressure, upon which evidence has recently been given—there is no Standing Committee such as that which assists the Government in Switzerland, and which is in close connection with the Swiss Institution of Electrical Engineers, thus assuring all the advantages of practical knowledge and technical skill, and the necessary weight in obtaining from the Government such legal enactments as from time to time become necessary.

Had such a Committee existed in this country, how valuable would its evidence have been in connection with the points raised before the Committee of the House of Lords on the Sheffield tramway case!

Instead of the individual opinions of the two professors, which are out of harmony with the views of other experts, authoritative evidence would have been given by a body representing the experience and knowledge of the industry.

Prof. Perry's evidence, as to the electrolytic effect of stray currents, is entirely opposed to the experiments of M. G. Claude, which proved that only about ½ per cent. of the whole current returns by way of the pipes along a tramway line; as we pointed out in our article of December 28th last, "on a section of track five miles long, with a five minutes' service, the current flowing along water pipes paralleling the route, would be of the order 1 ampere, a perfectly harmless rate."

Mr. Horace F. Parshall, speaking of his experience in Dublin, proved that no serious results occurred from electrolysis, and considered that the Board of Trade regulations afforded all the protection necessary.

With such a conflict of testimony, the action of the House of Lords' Committee in inserting the dangerous clause in the Sheffield Corporation Tramways Bill was probably due to their giving too much weight to opinions coming from witnesses able to say, "I am President of the Institution of Electrical Engineers," and a Past-President saying "Ditto" to his old partner.

Parliamentary Committees may well be divided in opinion when really authoritative evidence is absent, such as the Swiss Committee would afford; thus last year a House of Lords Committee inserted a clause in the London Tramways Bill No. 2, promoted by the London County Council, making them responsible for electrolytic damage to pipes and mains shown to arise from leakage of their currents; while a Committee of the House of Commons refused to allow similar clauses in the Croydon and South-Eastern Metropolitan Tramways Bills.

The report of the Joint Committee of the two Houses of Parliament in 1893 provided for a series of provisions dealing with electrolytic action, an important section making special regulations for the use of electric power for traction, and specifying that it shall be regulated by the Board of Trade, but notwithstanding these special regulations for preventing fusion or injurious electrolytic action on gas or water pipes, &c., the gas company have succeeded, with the assistance of Messrs. Perry and Ayrton, in getting a proviso inserted in the Bill which opens the door to litigation, although all the Board of Trade regulations have been complied with by the Sheffield Corporation.

We invite the opinions of all interested in electricity supply—especially those engaged in developing electric traction—upon the important question of how the industry can best be governed, with some such organisation as that of Switzerland, where electricity supply is in a prosperous condition.

Electricity in Calcutta.—The past year, says a writer in the *Bombay Gazette*, has been marked by a great development of electrical enterprise in India. In Calcutta the tramways company is adopting electric traction. The largest dynamos yet ordered for India are those for the Calcutta Electric Supply Corporation, whose engineer, Mr. Scott Moncrieff, has recently returned from England, having arranged for the delivery of two sets of engines and dynamos, each of 1,100 H.P. The electric fan has "come to stay," to judge by its great popularity in Calcutta. It hangs from the ceiling, and has much the same appearance as a chandelier with the addition of two, three, or even four large blades spreading some 54 inches from tip to tip. These blades, when the fan is working, make some 200 revolutions per minute, giving a slow, steady breeze of great volume. Electric fans are apparently better than swinging punkahs in every way. They certainly look much better, obstruct the room much less, ventilate the room much more, and they do not stop. We hear on all sides that they have changed the conditions of life in India. In addition, the workshops of the East Indian Railway and of the Bengal Nagpore Railway will be driven by electricity before long. Perhaps the greatest novelty of all is the Viceroy's new electric lift. When using the lift one first presses a button, which brings it from whatever floor it has been left at to that on which one is standing. One enters the lift, and finds a row of push buttons, each marked for a floor at which the lift may be wanted to stop; one presses the button, and the electricity does the rest. In order to ensure safety in working, the lift will not move until all doors are shut. In a lift of this sort no attendant is required, and the cost of working does not exceed one anna per trip. Electricity from the supply company's mains thus lifts the Viceroy, it lifts tea at the tea warehouse works, tea packers also, and drives many printing presses throughout the city.

THE DIESEL OIL ENGINE.

Although much has already been written upon the subject of this motor—the Review containing no less than five distinct references to it so long ago as the year 1898—the very interesting development of the principles of the heat engine, as exemplified in the Diesel petroleum motor, which was exhibited at work on Monday, the 25th ult., at the works of Messrs. Scott, Hodgson & Co., near Manchester, merit more than a passing comment.

The Diesel engine is now about eight years old, as far as its introduction to public notice is concerned, but the practical realisation of the theoretical principles involved has only been achieved within the last three years or so.

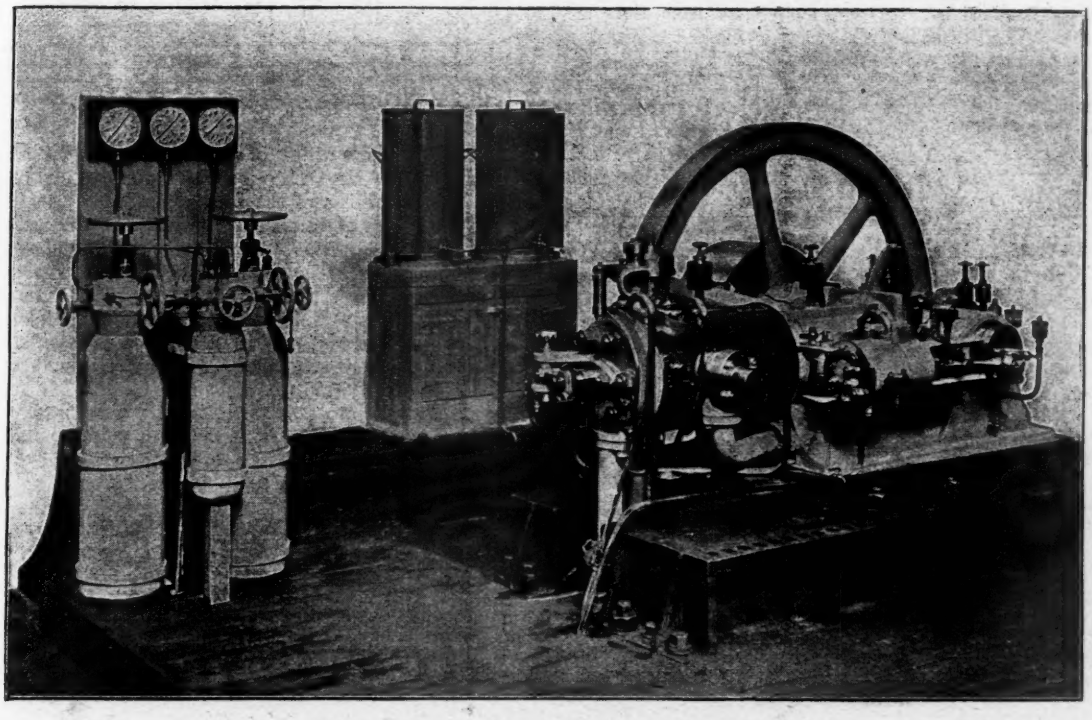
At the moment the question of economical power production is engaging a large share of the attention of engineers, and any motor which shows, even under laboratory conditions, a thermal efficiency greater than that of all other types of motor, cannot fail to awaken keen interest in a very wide circle.

The fundamental peculiarity of the Diesel engine is that the compression of the air in the cylinder prior to the working stroke should be carried to a point at which the temperature, due to the compression, is higher than that at which the fuel to be used will ignite.

The fuel used in the Diesel engine is petroleum, and it is asserted that either crude or refined petroleum can be used with almost identical results. The oil is supplied by a pump, the quantity delivered being regulated by a governor approximately in proportion to the load upon the engine, and is injected into the cylinder at the commencement of the working stroke by a jet of air through a sprayer at a higher pressure than that to which compression has been carried by the prior return stroke of the piston. The temperature of the compressed air injecting the oil being higher than that at which the oil ignites, causes combustion of the finely divided oil particles, but as the injection of the sprayed oil is timed to take place *after* the piston has reached the dead point, the explosive effect of ignition is mitigated, and as the piston moves forward with increasing rapidity, the effect of the combustion of the oil is to supply, as far as possible, to the expanding air the heat equivalent of the work it is doing, and the degree of success with which this is effected determines the extent to which the ideal Carnot theorem is realised, namely, the supply of heat isothermally during expansion at the higher temperature.

The original cycle upon which the Diesel engine was worked was the Otto cycle. The engine exhibited at Messrs. Scott & Hodgson's works, however, is a new departure in design in that an impulse is obtained every revolution. This is attained in the following way :—

Working tandem with the power-producing cylinder is an air pump which on the outward stroke takes in a charge of air. On the return stroke the air is pumped into a reservoir under the engine at a few pounds per square inch pressure above the atmosphere. When about four-fifths of the return stroke is completed, the air pump piston covers the port communicating with the reservoir, and the remainder of the air in the pump is compressed to about 60 lbs. per square inch, and delivered to a supplementary air pump which increases the compression to about 650 lbs. per square inch, and delivers it to a special reservoir, whence the supply is obtained for injecting and spraying the oil into the working cylinder. When about nine-tenths of the forward or working stroke has been completed, the exhaust valve opens, and shortly after communication is made between the air reservoir at about 4 lbs. per square inch and the working cylinder behind the piston. The effect is to scavenge the cylinder by a rush of pure air from the reservoir through the cylinder to exhaust. At a suitable point this scavenging action is caused to cease, and thereafter the piston compresses the air in the cylinder to the pressure needed for ignition of the oil and the working stroke recommences.



Diesel Oil Engine at Messrs. Scott & Hodgson's Works.

The two-stroke cycle is, of course, not new, having been introduced with considerable success in several types of gas engine, but its application to the Diesel motor is, of course, an important step in that—if successful—the power of the engine, for the same first cost and space required is practically doubled.

It is to be regretted that the arrangements for testing at Messrs. Scott & Hodgson's works were not more complete. From a scientific point of view it was impossible to glean any particulars respecting the working of the motor on exhibition as a heat machine, nor did those in charge of the machine seem to know much about the character of the oil that was being used, and no estimate of the load on the engine could, of course, be formed.

Through the courtesy of the chairman of the company we were enabled to take an indicator diagram from the working cylinder and from the supplementary air-pump. The shape of the indicator diagram of the power stroke shows a remarkable advance upon anything hitherto achieved in internal combustion engines. It shows that Mr. Diesel has been able to keep the maximum temperature reached in the cylinder many hundreds of degrees lower than that of any gas or oil engine hitherto known, because the fuel is supplied, comparatively speaking, *gradually*, to a volume of very hot expanding air which is greatly in excess of that necessary for complete combustion of the fuel injected. The result is, that the large excess volume of air and the expansion thereof during the rapidly increasing forward velocity of the piston, absorb a large amount of the heat which—in the case of ordinary oil engines when an explosive mixture is drawn in, compressed and fired—produces an extremely high temperature, a considerable proportion of the heat produced being carried away to waste by the cooling water.

It is contended that the amount of heat absorbed by the cooling water in the Diesel engine is very much less than in any other form of internal combustion motor. This is no doubt the case, but it would have been interesting if arrangements had been made at Manchester to measure the temperatures of the circulating water, and of the quantity of oil consumed.

The efficiency of the Diesel system of converting heat into work is remarkable. Lord Kelvin says, "Diesel has actually obtained 58 per cent. more work from the same weight of oil than that given by any of the best oil motors previously made."

The Diesel company state that since Lord Kelvin investigated the engine the consumption of oil has been reduced to 205 grammes of oil per brake horse-power-hour.

Taking the calorific value of the oil used during Prof. Meyer's test at 40,788 B.T.U. per kilogramme, the above result means that the Diesel engine can turn $\frac{2,544}{40,788 \times \frac{502}{1000}} =$ 30·4 per cent. of the heat value of the oil consumed into useful work. Of course, the proportion per indicated horse-power-hour would be much higher.

The mechanical efficiency of the Diesel motor must of necessity be comparatively low on account of the supplementary air pump. Further, the necessary gear for operating the valves on the two-stroke cycle and the massive character of the design generally are apt to give one the impression that the Diesel engine is a complicated machine. The term "complicated" as applied to a machine always conveys an invidious meaning, and therefore while freely admitting the existence of more working parts in the Diesel engine than in any ordinary oil engine, it only seems fair to defer any expression of opinion as to whether "complication" is thereby involved until the test of time has been applied.

With regard to efficiency, neither heat efficiency nor mechanical efficiency or any other attribute taken by itself is a sufficient criterion. The efficiency that engineers have to deal with is the ratio $\frac{\text{What you get}}{\text{What you pay for}}$.

What you get from an engine is available useful power; what you pay for is fuel, labour, money locked up, space occupied, repairs, depreciation and maintenance.

If one type of engine can give you 1 B.H.P.-hour at a less total cost than any other, it does not matter whether the former has 5 or 500 more working parts than the latter.

Whether the Diesel engine will fulfil all the anticipations of its owners, particularly as regards working with coal dust, time only will show. It cannot be denied, however, that the practical application of Mr. Diesel's principle of supplying heat to the working fluid in an internal combustion motor has reached a very interesting stage, and its future development will be watched by engineers with interest.

Ludlow.—The Town Council has adopted a report on the electric lighting of the town, prepared by Mr. J. Parker, city surveyor of Hereford. The cost of the proposed installation is estimated at £7,350.

THE CARD SYSTEM APPLIED TO CENTRAL ELECTRIC SUPPLY STATIONS.

By F. W. FARRERWHITE.

[Note.—The Card system, as described here and in the Electrical Review of March 22nd, is the same as that in use at the Brighton station, and was first introduced into England by Mr. Arthur Wright, of that station.]

(*Concluded from page* 484.)

(4) *Meter Changing Cards.*—To ensure as far as possible the maintenance of the standard of accuracy of all meters fixed on the consumers' premises, it is necessary that a system of periodical changing should be in use. For this purpose a card, as shown in fig. 6, is written for each consumer.

Name ..... Address .....

District ..... Pressure ..... Meter Type .....

Capacity	Max. Demand	No. of Meter	Notice Sent	Date Fixed

Fig. 6.—Meter-changing Card (⅜ size).

Where the Brighton system of charging is adopted a column as shown in the illustration is retained for the insertion of the maximum reading of the demand indicator previous to the change taking place, which affords a guide to the size of the new meter required. Although the card contains much useful information, the real purpose is to indicate those installations where the time for the periodical change of meters has arrived. This is accomplished in the following manner:—The cards are in the order of the month in which the meters were fixed (each month being divided by a guide card) and in alphabetical order. The set is then divided into yearly sections by a coloured guide card bearing the number of the year in which the meters are to be changed; thus if the period allowed be two years, the meters fixed in 1899 would have a year card showing 1901, as shown by fig. 7. This method of arrangement

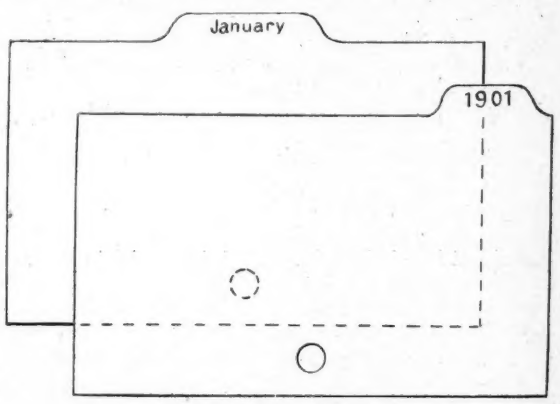


Fig. 7.—Guide Cards.

ensures that no meters are on circuit a longer period than two years. Should a meter be changed before the time allowed expires, the particulars of the new meter are entered on the card, which is then placed under the new date of change. By the aid of this set of cards, periodical tests of each installation may be taken for the purpose of keeping the I.R. up to standard.

(5) *Meter Diary.*—One of the most important uses to which the card system can be applied is that of keeping a

record of all meters, thus replacing the meter diary. Each meter has a card on which is given the maker's number, the capacity, and type (fig. 8). The set is divided into two

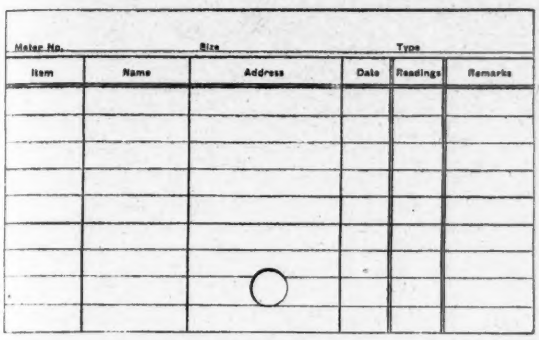


Fig. 8.—Meter Diary Card (⅛ Size).

sections: one for meters in stock, the other for meters on circuit. All cards relating to meters of the same type are placed together and arranged in sections by guide cards, such as those shown in fig. 9, according to the

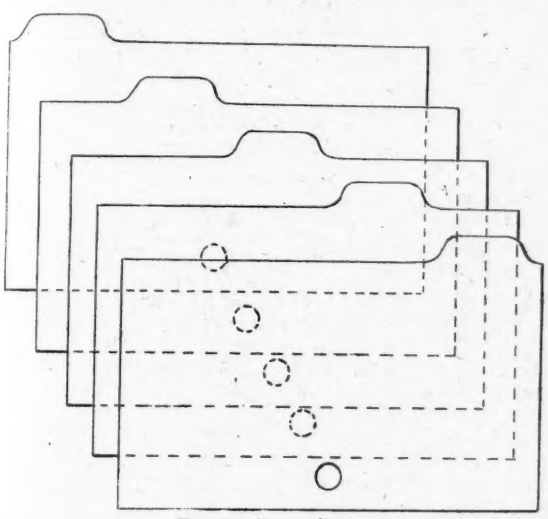


Fig. 9.—Guide Cards.

capacity of the meter. The cards in each division are then arranged in numerical order, thus obviating any two meters of different types and bearing the same number coming together. By the use of this arrangement, it will at once be seen that the total number of each size of meter in stock may be quickly determined, and the where-

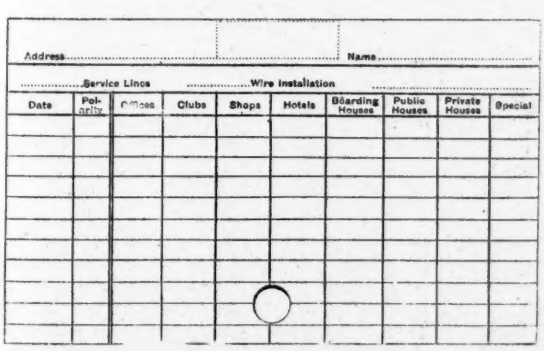


Fig. 10.—Balance Card (⅛ Size).

abouts of any meter easily located. Should demand indicators be in use, a diary conducted on the foregoing lines may of course be adopted.

(6) *Balance Cards.*—To those stations having the three or five-wire system of distribution in use, cards may be employed by means of which the load on the station can be effectively balanced. A card similar to fig. 10 is allotted to each consumer, and his demand in amperes is entered in the column appropriate to the description of his premises. The cards are of three different colours, white denoting two service lines laid and in use, pink three service lines laid and only two in use (otherwise called three-wire change-overs), and blue three service lines laid and in use. The drawer is divided into two parts, one side for negative, and the other for positive. If any particular feeder should be found to be

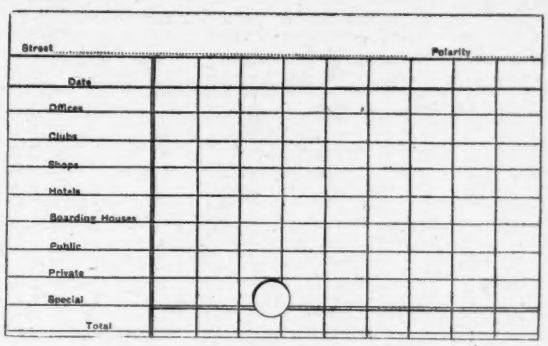


Fig. 11.—Street Balance Card (⅛ Size).

out of balance, this can at once be rectified by a three-wire change-over, the card for which, when the change has been made, is transferred to the other side of the drawer, the date of the change being noted on the card. For the purpose of summarising the balance of each street, cards similar to fig. 11 are used, giving the total demand in amperes of each class of consumers' premises. The cards in each side of the drawer are arranged numerically in alphabetical order of street.

When a consumer is disconnected, all the cards relating to his installation are taken out of their respective drawers and put together in a section devoted to idle services. By this arrangement all dead matter is eliminated, and a unique record is furnished of all disconnections.

(3).—General.

Among the various general uses to which the card system may be applied, special mention may be made of a card showing the record and terms of engagement of each member of the staff employed in the station; and such particulars as to the duties, method of working, character, &c., are easily available for reference.

In addition, however, to the uses already enumerated, the card system may be applied to other purposes too numerous to describe in detail. A few of these may be briefly indicated. As a record of :—

(*a*) Specifications, contracts, tenders, and quotations.

(*b*) Prime costs, abstracts and general financial data.

(*c*) Pressure test curves, station load on feeders, and other technical data of generation and distribution.

(*d*) Arc lamps and other information relating to street lighting.

(*e*) As a classified index of plans and drawings relating to the station.

(*f*) As an index to catalogues.

Drawers supplied by the Library Bureau, Limited, are ingeniously devised so as to accommodate the greatest number of cards in as small a space as possible. These are fitted with a rod which locks the cards in position, and a false back adjustable to suit the number of cards in use.

The system here described may, of course, be varied to meet the requirements of individual stations; the object of this article has simply been to indicate the general outline of a system which has fully established its efficiency in actual practice.

For whatever purposes cards are used, it will be found that the time and space saved, the methodical arrangement whereby reference is greatly facilitated, together with its infinite elasticity in accommodating any number of additions without disturbing the primary order, render the card system peculiarly applicable to central supply stations.

E

CURRENT SPECIFICATIONS.

LV.—KIRKCALDY ELECTRIC LIGHTING.

Summary.

Extent of Contract.—Specification No. 2—Supply of five steam dynamos, and erection of same upon prepared foundations.

Size of Units.—Three to be capable of developing 136 KW. at 480 volts, or 150 KW. at 550 volts; the other two each to consist of two 24-KW. machines direct coupled to one 80-I.H.P. engine.

Type of Engine.—Vertical three-crank triple or compound, preferably of the enclosed type.

Specified Speed.—The three larger engines are not to run faster than 400 revolutions per minute, and the two smaller ones 450 revolutions per minute.

Specified Steam Pressure.—At present 150 lbs. per square inch, but tenderers are to state whether engines can safely be worked at 190 lbs. per square inch.

Type of Outer Bearing.—The bearing carrying the dynamo spindle to have a spherical adjustment of a design to be approved by the engineer.

Range of Governing.—If whole load is suddenly thrown on or off, the variation of steady speed is not to exceed 3 per cent., or of momentary speed 10 per cent. Type of governor to be suitable for dealing with a rapidly fluctuating traction load.

Type of Dynamos.—To be multipolar, with slot-wound drum armatures.

Type of Winding.—The three large machines to be compound-wound suitable for use either as shunt machines for lighting, or as compound machines for traction work. The smaller machines to be simply shunt wound, and are to be placed one on each side of the engine driving it.

Range of Voltage.—The three larger machines to give as normal full load output 136 KW., or 280 amperes at 480 volts. To be suitable for working as shunt machines at any voltage from 460 volts to 520 volts, or as compound-wound machines of developing 150 KW., from 500 volts at no load to 550 volts at full load.

Each of the smaller machines to be wound for normal full load at 240 volts, and to be suitable for working at any voltage between 230 volts and 260 volts.

Specified Overload.—25 per cent. for one hour over 150 KW. for the large sets, practically 10 per cent. continuously for the small sets.

Permissible Temperature Rise.—70° F. measured thermometrically after six hours' run at normal full load.

Specified Combined Efficiency of Each Steam Dynamo.—Not to be less than 80 per cent. at full load for the large sets, or 78 per cent. for the small sets.

Specified Steam Consumption.—Not to exceed for the larger sets working non-condensing with 150 lbs. steam pressure 24 lbs. per E.H.P.-hour, or 32 lbs. per KW.-hour at most economical load, or for the small sets working under similar conditions 28 lbs. per E.H.P.-hour, or 37·5 lbs. per KW.-hour.

Spare Parts and Accessories.—To be supplied as specified.

Specified Date of Completion.—To be stated in tender.

Penalty for Late Completion.—£20 per week.

Specified Period of Maintenance.—12 months from completion of work.

Specified Terms of Payment.—75 per cent. of value of work done as manufacture proceeds, balance up to 85 per cent. of contract sum on completion of delivery; 10 per cent. additional on completion of work; and last 5 per cent. at end of period of maintenance.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages paid to Workmen.—Acceptable, see comments below.

Surety Arrangements.—Either two sureties to be provided or retention money to be increased from 5 to 10 per cent.

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—April 15th, 1901.

This specification has been prepared by Messrs. Kennedy and Jenkin, the consulting engineers to the Corporation, and is interesting if only on account of the thorough manner in which it has been prepared.

Tenderers will note that three-crank engines are specified either compound or triple expansion, and that they are to state in their offer whether the engines they propose to supply will work equally well with steam at 190 lbs. pressure in place of the 150 lbs. per square inch available at the present time.

It will be well to carefully note the large amount of overload which it is specified the 150-KW. machines shall be able to give for periods of one hour continuously without overheating.

The general conditions are fair, and may be accepted in their entirety without undue risk. It is stipulated that standard recognised rates of wages shall be paid by the successful contractor, and that failing acquiescence in the decision of the engineers on any disputed point, resource may be had to the arbitration of the President of the Institution of Civil Engineers, or to that of some member of the Institution appointed by him.

Delays caused by fires, or strikes of workmen, are to be taken into account when calculating damages for late completion of the contract works.

BEHR'S MONO-RAILWAY.

This idea is gradually being brought into practical shape. In the early days of the proposed Manchester and Liverpool Behr Railway, a good deal was said about high speeds and safety when running round curves, as though all that was necessary to be done was to provide means to take up the centrifugal stresses due to the train only. Passengers did not count, and we had to point out that if speeds of 100 miles per hour were run round curves of what we will term short radius, the passengers would hang like wet towels over the seat backs. Mr. Behr, in fact, like many other enthusiasts, has been too ready to assume all the virtues for the railway system he is pushing, and has been hiding his head in the sand in the hope that by so doing the sight of others would be similarly obscured. But doing this cannot annul the laws of mechanics, and in his recent paper on the subject which we have reprinted, we are glad to see that definite statements have taken the place of general platitudes. Thus we are told that a speed of 83 miles per hour was recorded round a curve of 540 yds. radius, and we are now told that on the proposed line the minimum curve will have a radius of 750 yds. As regards speeds of 120 or 130 miles per hour we do not think much. They should be easy to attain on a sufficiently straight line. It is simply a question of power, and Mr. Behr can no doubt find out from electrical constructors how much power he must put into a car of 60 or 70 ft. length to secure such speeds, how large or how many must be the motors to move such a car in 20 minutes between the two cities. On this subject Mr. Behr tells us nothing beyond that he will have a station of 7,500 H.P. capacity. This is for a 10 minutes' service, and there will be four trains running at one time, so that the motive power of each train is apparently calculated at nearly 2,000 H.P. for one carriage only. We should like to hear more about the power and less about the brakes. The stopping of a train can be effected just as quickly as the sitting power of the passenger will allow, for it can be done by grip brakes. The only consideration is that the structure must be such that the grip brake employed shall not rip it up. In bridge work it is usual to calculate the braking effect of the train as regards its buckling effort on the chord on which the stress is resisted, and very careful calculations will need to be made in regard to the destruction of the stored energy of a car at 130 miles per hour when quickly brought to rest by a grip brake. Especially at points of curvature will this effect be apt to cause danger, for it is only on a straight line that the rails can resist as a strut. Thus, as regards both the safety of the proposed speed and the possibility of rapid retardation, we see no reason to doubt the system, but we should like to see figures of the power required and of the size and speed of the motors, the space they are going to occupy, and so on.

As regards retarding effort, it is stated that speed can be retarded at the rate of three miles per hour per second. Thus a train at 60 miles per hour should be stopped in 20 seconds, and one at 110 miles an hour in 37 seconds, during which time it will run 995 yards. This is with the Westinghouse brake, while with a magnetic brake acting on four grip rails, a train at 110 miles per hour should be stopped in emergency in 500 yards. Prof. Carus-Wilson, in the discussion on the paper, however, doubts the friction brakes being possible, because so much energy has to be dissipated. Would it not be possible to carry water to use on the friction brake at times of emergency? Lieut.-Col. Alan Cunningham pointed out the necessity for tilt round curves. We want to see the Behr railway at work, and are glad to see that the effect of centrifugal force is more fully recognised than it was even a

year ago. High speed running is fully as easy and smooth as low speed work, and the whole question resolves itself into one of power and straightness. Those who know anything of the size of a 30-H.P. tramcar motor will naturally ask for information about the motors to absorb 2,000 H.P. Where are they to be placed? What is their speed and diameter, and do they really need to be of such a power as the central station estimate appears to indicate?

BRAKE POWER OF LIVERPOOL ELECTRIC CARS.

In our issue of March 1st a paragraph appeared in reference to the backward movement of an electric car laden with passengers during the ascent of Everton Valley, on a portion of what is known as the Liverpool belt route. The incident in question was also referred to by the local press, and certain official inquiries were consequently made as to the precise circumstances attending the incident. The exact facts of the case were as follow :—A car, in taking the crossing at the intersection of the Everton and Kirkdale Road, got its trolley off the wire, and, being on a gradient of about 1 in 29, the car moved back not more than half its length during the process of applying the brake. The hand brake alone was used, though all of the cars on the Liverpool tramways are fitted with an electric brake as well as a hand brake. The car was subsequently taken down on the up-track to the crossing, preparatory to going into the shed for repair of the trolley-head which had been damaged.

Interest being aroused in Liverpool by the reports of the incident, a series of official tests of the brake power of cars on gradients were carried out. The following were the results as officially certified by Mr. C. R. Bellamy, manager of the Liverpool electric tramways :—

Liverpool Corporation Electric Cars.

On March 19th, 1901, at Everton Valley, on a gradient of 1 in 17, there were taken various tests with an empty car weighing 8½ tons:—

1*st Test.*—Running up the hill taking the trolley off the wire, and as soon as ever the car began to move backward again it was brought to almost a stop in 1 ft. by the action of the motor becoming a generator and so braking itself. When the speed of the motor became practically *nil*, then the car moved again, and continued moving at the rate of about half a mile to one mile per hour down the hill, but was again brought to rest in a few yards by the action of the electric brake. On such an incline the effect of the use of this brake is to bring the car to rest and liberate it alternately.

2*nd Test.*—Running the tramcar at the rate of about 10 miles an hour down the same gradient of 1 in 17, and at a certain point the hand-brake was put on and the car was stopped (the lines being dry) in 12 yards.

3*rd Test.*—Running at the same rate down the same dry lines, and down the same gradient of 1 in 17, using the electric brake at a given point, and the car was brought violently almost to a stop in 2 yards by means of the motor again acting as a generator, and in the same way as before it moved very slowly down the hill, but was again brought to rest in a few yards by the action of the electric brake. On such an incline the effect of the use of this brake is to bring the car to rest, and liberate it alternately.

4*th Test.*—Watering the rails on a gradient of 1 in 14 at the bottom of Everton Valley, running the car at 10 miles an hour, using the electric brake alone, when, without the application of sand, the car was brought to a standstill in 23 yards.

5*th Test.*—Using the electric brake first, the hand brake to hold the car, and sand down the same gradient of 1 in 14, and at the same speed, when the car was brought to a standstill in 14 yards.

With respect to accidents on the Liverpool electric tramway system, the following particulars will be of interest. During the year 1900, there were 11 fatalities in connection with the working of the electric car system, and the horse cars in Liverpool. In no instance was a passenger fatally injured. Five persons were killed by horse cars, and six by electric cars. The ratio of comparison of fatalities under horse traction with the number of passengers carried, and electric traction, was one in 5,000,000 under horse traction, and one in 10,000,000 under electric traction. The Board of Trade returns for the last year available, show that 1,200 persons were killed during the year on railways in the United Kingdom, which worked out to one in 800,000 passengers carried. The experience of working the electric tramway system in Liverpool, proves, therefore, that with all the concomitants of crowded streets with vehicular and pedestrian cross traffic, electric traction is much safer than horse traction.

ELECTRICITY IN MINES.

This might have been the title applied to the double-barrelled meeting of the Institution on March 28th, when Mr. H. W. Ravenshaw read his paper "On the Electrical Transmission of Power in Coal Mines," and Mr. S. F. Walker abstracted his communication on "Electrical Miners' Safety Lamps." A correspondent, through the President, asked why electricians did not contrive a lamp to be fixed to the cap, as in the practice of French and Scottish miners.

Mr. Kapp opened the discussion, and thanked Mr. Ravenshaw for his thoroughly practical paper. He was surprised to find the list of troubles so short, as it proved electricity in mining to be a very safe form of working. The author, in dealing with switch gear for motors, advocated paralleling the shunt with a resistance. It was an old, but a somewhat expensive advice; colliery managers would rather sell their coal than use it in this way. The well-known device of connecting the shunt across the end of the starting resistance might be used. Another device was to employ a variable resistance, not liquid, but in the form of powder, so as to diminish the current for switching off. Smooth core armatures are not so good as toothed for mining, and are not so liable to break down, but paper is not the material to use for insulation. Two and three-phase motors were left out of the paper, but with them many difficulties vanished, as connections to commutators were avoided. There were absolutely no exposed parts, and such motors could be soaked with water and yet work. For power schemes Mr. Kapp preferred a frequency of 25 periods and direct-coupled pumps and motors.

Mr. A. P. Trotter was disappointed to find how short the paper was, but it was solid with facts. Conditions in mining were impossible for outsiders to predict. The happy condition existed that coal mining was not "regulated," but when someone had to prepare regulations, this paper would be invaluable. It was pointed out in 1887 by Atkinson that motors absolutely enclosed were running, and at work, in gassy mines.

Prof. Le Neve Foster, as a mining engineer, wished to correct the statement that cables down a shaft had to be protected, because falls were frequent; they were *not* frequent, but judging by accidents, they were infrequent indeed. Electrical locomotives were at work in French mines. He suggested that tools should be given to miners, capable of being used in any position, and then a man would not mind another pound weight in his lamp. He thought a large number of Sussman lamps were in use.

Two or three other speakers dealt with the danger from sparking and the troubles experienced with electrical miners' lamps. A gas detector did not seem to be a necessity. Except in the matter of weight, the electric lamp had a decided superiority; it could be used to examine the roof, gave a better light, and was safer. An ordinary safety lamp fired gas if it got broken. Mercury switches were not liked, as they were liable to be extinguished by a jerk.

Another mining engineer protested against the notion that coal was allowed to fall from the cages down the shaft. It was difficult to get a cable down a shaft, and an awkward matter getting out sections for repair. If a cable were hung between wooden clamps, moisture attacked the insulation at the point of contact.

Another speaker gave the solution to this problem; he had arranged to suspend the cables down the shaft from top to bottom, the weight being about 2 tons. By keeping the cable clear of fixings a bare conductor might be used; he had never had a breakdown on shaft cables, which were tested by an ohmmeter every Sunday evening. Tubs tumbled down and scraped the cable, but there was nothing for any falling object to catch. The cable turned in at the bottom, and joined on to armoured cable after a dip down to throw off moisture. The pressure used was 500 volts,

and the shafts were 600, 400, and 330 yards deep. 19/12 was the largest cable, and it had a factor of safety of 8. The cables had been in use since 1893, and showed no signs of stretching. They could be hung in the shaft in half an hour, and it was a cheap way of surmounting obstacles. The motors were all shunt-wound, excited across the first step of the starting switch; liquid resistances were a nuisance in a colliery. Gramme armatures, being easily repairable, were the things for colliery use. Coal must be drawn in a certain time, and the new Eight Hours' Bill will limit the time still more. The thing to be considered was the quickest way to effect repairs. Four breakdowns of drum armatures occurred to every fault on a Gramme. Haulage work underground was similar to tramway work.

Steam turbines were put down by one of the speakers in 1895 and had worked night and day from 1896, just like tramway stations on continuous service; 1,000 H.P. was installed. They governed well, and the only trouble was if oil got below sample grinding and wear took place. The efficiency was not nearly so bad as colliery engines; it was from 39 to 40 lbs. per kilowatt-hour. There did not appear to be any appreciable sandblast action or wean on the blades. In 1897 three-phase coal-cutting motors were tried and found satisfactory and were now being extended.

The replies by Mr. Ravenshaw and Mr. Walker will be taken at the next meeting which is to be held on April 18th.

REVIEWS.

Electric Generators. By H. F. Parshall and H. M. Hobart. London: Offices of *Engineering*. 1900.

In opening, the authors very gracefully acknowledge the work of the late Dr. John Hopkinson, the founder of the "Science of Dynamo Design," and of Dr. Silvanus Thompson, whose treatise on "Dynamo-Electric Machinery" has had the greatest influence in disseminating thorough knowledge of the theory of the dynamo.

The first chapter treats most fully of permeability and hysteresis tests, the properties of cast and wrought-iron, cast-steel, sheet-iron, &c., curves and analyses being given showing the magnetic effect obtained by varying the percentages of combined carbon, graphite, phosphorus, silicon, manganese, sulphur, also aluminium in the case of "Mitis iron," and nickel in the case of "nickel steel."

The particulars as to the deterioration of sheet-iron are exceedingly useful, and go to show that whilst iron can be obtained which will not deteriorate at 60° C., other irons may deteriorate rapidly at this temperature, and at 90° C. even the more stable brands of iron go off gradually. In connection with ageing, the authors mention that at least 0·4 per cent. of manganese should be present, owing to its property of raising the specific resistance. Elsewhere they say that manganese in amounts less than 0·5 per cent. has but little effect upon the *magnetic* properties of ordinary steel.

The pages dealing with insulating material are so full of valuable information that it is quite hopeless, in the space at disposal, for the writer to emphasise any one point. On the important question of drying, the authors say quite rightly that the vacuum oven is the only way to thoroughly get rid of moisture.

The section dealing with armature windings reminds one of another book by the same authors, which deals exclusively with this subject. In the book under review, however, they give much additional information, making comparisons of three-phase rotary converters for two and six circuits, also alternator and induction motor connections, &c.

In stating the fundamental dynamo formula, the authors depart from usual practice by taking note of the number of magnetic cycles per second, instead of revolutions per minute and number of pairs of poles. As they point out, it is the periodicity which determines or limits the core loss, tooth density, eddy current loss, and through the armature inductance affects the question of sparking. It is, of course, also a leading consideration in the design of rotary converters.

After going most thoroughly into the question of the estimation of the temperature rise of armature, commutator, &c., the authors treat most fully of the design of typical magnetic circuits, working out numerous windings for actual cases.

A particularly valuable feature of the book is that complete designs are given of the following machines:—

1,500 KW., 600 volts, 12 poles, 75 revolutions.
200 „ 500 „ 6 „ 135 „
300 „ 125 „ 10 „ 100 „
250 „ 500 „ 6 „ 320 „
24-H.P. tramway motor, 4 poles, 555 revolutions.
27 „ „ „ 4 „ 640 „
117 „ railway motor, 4 „ 190 „
Six-phase 400-KW. rotary converter.
Three-phase 900-KW. rotary „

This policy of publishing full data of large modern dynamos is so rarely met with, that one is loth to criticise, even in the smallest degree, the figures given. There is one point, however, which the writer would like to mention in connection with the dynamo designs. It is generally assumed in this country that to get sparkless reversal, the cross ampere-turns per pole on the armature should not exceed the value of the ampere-turns on the field for the gap. Now in the designs given by the authors, the cross ampere-turns so greatly exceed the gap ampere-turns that the proportions appear to be somewhat precarious. The satisfactory working of such machines must be largely dependent on the employment of high resistance German silver or rheotan commutator lugs, the saturation of the pole tips, the use of carbon brushes, and most important of all, to the fact that the machines are *over-compounded*, and increase of magnetisation corresponding with increase of voltage gives a condition favourable to sparkless commutation by keeping up the strength of the field under the horn which tends to weaken. The amount of series ampere-turns in the largest machine is particularly high, as will be seen from the following:—

		Ampere-turns per pole.
1,500 KW.	shunt	9,960
	series	8,300
200 „	shunt	7,630
	series	3,360
300 „	shunt	6,250
	series	4,310
250 „	shunt	5,570
	series	2,770

The practical notes on the construction of details of armature, poles, commutator, brush gear, &c., are valuable, the more so, as the drawings are all to scale.

The last 85 pages of the book deal exclusively with rotary converters. The advantages of polyphase over single-phase rotaries are pointed out, and full particulars are given of methods of starting and synchronising, adjusting voltage ratio, predetermination of phase, characteristic curves, compound winding, &c.

Undoubtedly this book is the best complete practical treatise that has yet been published, and those interested in dynamo design simply cannot afford to be without it.

E. K. S.

Dynamo-electric Machinery. By S. Sheldon, Professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn, assisted by H. Mason. London: Crosby Lockwood & Son. New York: D. Van Nostrand Company. 1901.

A feature of this book is that the matter is arranged in numbered paragraphs, with heavy type at the beginning of each, so that any point can be looked up quickly. It appears to be essentially for students, to whom it should prove useful, on account of the terse and clear manner in which the various important points in continuous current dynamo design are explained.

The winding diagrams are small but clear, and as several can be got on to one page, it is a convenience in making comparisons.

The authors go somewhat fully into the question of commutators, and the remarks do not always agree. They say:—

"Commutators should be designed so as to expose a sufficient area to radiate the heat which is communicated to

them. Except in the case of some special commutators, (which are supplied with cooling devices) at a peripheral speed of 2,500 ft. per minute, the radiation of 1 watt per square inch of peripheral radiating surface will result in a rise of temperature of 20° C. The permissible rise of 55° C. therefore allows a radiation of 2·75 watts per square inch."

"Friction between the brushes and the conductor bars is equal to $\frac{(2 \times \pi \times 746)}{33{,}000}$ times the product of the following quantities:—The radius of the commutator in feet, the speed in revolutions per minute, the co-efficient of friction between the brushes and the commutator (0·3 for carbon brushes, and 0·25 for copper brushes), and the sum of the pressures of all the brushes upon the commutator. This latter should amount to 1·25 lbs. per square inch of rubbing surface." . . . .

"As there is always a drop of about 1 volt at each point of contact, and as there is a drop at both the positive and negative brushes, the watts represented by these contact resistances are numerically equal to twice the current of the machine." . . . .

"Friction of the brushes against the commutator varies about as the speed, and its importance is generally underestimated. Carbon brushes press upon the commutator with a force of from 1 to 12 lbs. per square inch of contact. Railway motors and similar machines have the larger value, while central station generators have the smaller. The co-efficient of friction between copper and carbon varies from 0·28 to 0·32."

The very excellent and complete report of the Standardisation Committee of the American Institute of Electrical Engineers is frequently referred to, and extracts are given in the paragraphs dealing with rating of machines, rise of temperature, efficiency, regulation, spark-gap voltages, and the testing of dielectric strength.

There are some bits of history in the book. Thus we are reminded that the Edison Company, of New York, in the case of its Duane Street dynamos, allows the field circuits to discharge themselves through an arc light. Again, in the chapter devoted to a description of the various constant current arc lighting dynamos there is a description of the Ball Electric Company's regulator, in which the impulse is applied directly to the brush-holder instead of being communicated to it by more or less complicated mechanism. A portion of the brush carrier is made a part of the magnetic circuit, and so placed in a recess of the dynamo frame that it tends to assume an axial position with a force varying as the flux through it. As the line current increases, the flux increases, and the brush-holder, which is mounted on ball bearings, rotates, shifting the brushes the required amount.

The difference between ordinary compound-wound and cumulative compound-wound motors is explained, and several pages are taken up by the description of series-wound motors for traction work, &c. Various systems of controlling the speed of motors, including the Leonard and the Bullock teaser system, are given. There are also particulars of automatic brakes which come into action directly current is cut off in connection with such apparatus as elevators, hoists, looms, printing presses, &c.

The three last chapters on the Management of Machines, Design of Machines, and Tests, are fairly good.

E. K. S.

The Winding and Construction of Armatures of Continuous Current Machines. By E. Arnold, Professor and Director of the Carlsruhe Electro-technical Institute. 1900.

This book has gone through several editions in German, and has recently been translated into French by M. Boy de la Tours, electrical engineer of the Compagnie Fives, Lille.

It is a book of 400 pages, with over 418 figures and 12 large plates, and is a monument of the exact science which dynamo designing has become.

Prof. Arnold has been through the mill himself, and he therefore brings great judgment to bear on the subject. He follows up points which are of real importance to the designer until they are thoroughly threshed out, and, on the other hand, contents himself with merely mentioning several special methods of winding which have been introduced from time to time, and which, although possibly ingenious, are not of real manufacturing value.

The Arnold series-parallel system of winding armatures —which is so much used on the Continent—is fully described.

There is no history, the figures are all right up to date, and altogether it is distinctly a book for the practical man. The large amount of data of Continental multipolar machines which it contains makes it of value for reference.

E. K. S.

CORRESPONDENCE.

Superheated Steam.

In the paper read by Mr. Raworth before the Institution of Electrical Engineers (Manchester Section), he calls attention to the economical results obtained by Mr. Schmidt in his application of highly superheated steam in a compound engine as compared with the results obtained in a triple-expansion engine with saturated steam.

In the discussion which followed, Mr. Lindley, although he did not question the economy thus obtained, suggested that to "compare Mr. Schmidt's system against the ordinary system," it has to be borne in mind that it is necessary to have a Schmidt engine, a Schmidt boiler, and a Schmidt superheater.

From such a statement, it is evident that Mr. Lindley up till now has had no experience of the Schmidt system.

1. The adaptations necessary to ensure efficient working with a high degree of superheat are such as may be easily made in any design of engine.

2. No special "Schmidt boiler" enters into the system at all, and the Schmidt superheater is applicable to any type of boiler.

Mr. Browett complains that "what Mr. Schmidt said he could do they had to take on faith," but seeing that Mr. Schmidt's statements are supported by prolonged practical working of some hundreds of engines, it would follow that Mr. Browett must, in most such matters, "live on faith."

Easton & Co., Limited.
T. Percival Wilson, *Joint General Manager.*

March 28th, 1901.

Electric Carbon Manufacture.

May I take the liberty, through your valuable paper, to ask the British electric firms a question? It is really a curious thing that British firms, with the exception of a single one (for their own use), do not pay any attention to a very interesting manufacture which is calculated to be of enormous benefit, especially when it is borne in mind that Britain bears in her ground the best material for it. During the time of my appointment in a big Continental carbon factory, where carbons for electric lighting and electrolysis were made, I had the opportunity to see that the best stuff for the production of these carbons, electrodes, carbon dynamo brushes, battery carbons, and lightning arresters, had first of all to be imported from Britain.

Ernest Schleich.

London, E.C., *March 30th*, 1901.

High Voltage Lamps.

We notice that at the Board of Trade inquiry into the question of the change of electrical pressure, several expert witnesses brought forward the subject of the inefficiency of the 200-volt lamp.

It may be of interest to state that we have lately been carrying out tests on both 200 and 100-volt lamps, and we may mention that we have found, taking an average number, that the 200-volt lamps of one maker consumed at start 4 watts per candle, increasing to 4·3 watts per candle after 500 hours, whereas the same maker's 100-volt lamps consumed 3·5 watts per candle at start, increasing to 3·7 per candle after 500 hours.

In the case of another maker, the 200-volt had an efficiency of 2·8 watts per candle at starting, increasing to 3·2 watts per candle after 500 hours; whereas the 100-volt lamps by the same maker consumed 3·1 watts at first, increasing to 3·7 watts per candle after 500 hours.

Of course, it is not our place as independent testing authorities to offer opinions on results, but we give these results for what they are worth, hoping that they will be of interest.

The Electrical Testing Laboratories, Limited.
L. W. Wild.

Westminster, S.W.,
March 30th, 1901.

A Charge Engineer's Complaint.

I should like to make a few remarks on Mr. Rider's reply to my letter *re* the above. I was not aggrieved because my application was not successful, but took the matter up simply in the cause of justice and in the interest of engineers generally. I am now told that the vacancy in question was not filled until March 18th, but in the letter I received from Mr. Rider before March 12th, he said that another person had been appointed, and as he gave me his word for it, I suppose I was justified in taking it, and also in assuming that the matter had been previously settled. However, I am glad to learn that such was not the case.

An Unsuccessful Candidate.

I should like to support your correspondent's complaint as to the manner in which applications are treated as a rule, although in the case under consideration the attack was unjustified—in fact, Mr. Rider's method of dealing with applications is to be very much commended, though the use of an obsolete form was misleading.

In numerous cases I have not had my application acknowledged at all, in others it has been two or three months before I have been informed of the result, and surely an appointment does not take all this time to be decided. But as regards the Plymouth case, I, like your correspondent, sent in my application at once, and previous to which my name was, I believe, unknown to the Plymouth officials.

On the 15th ult. I received a notification asking me to attend on the following Monday, the 18th ult. This I did, and I am quite sure that Mr. Okell would not have devoted the time he did in interviewing and escorting me round the works had "*the matter been settled before the advertisement appeared.*"

Others may still doubt Mr. Rider's statements, but I can fully bear them out, although I was

The Unsuccessful of the Two.

Bath, *April 1st*, 1901.

Cost of Coal.

What can be taken as a fair price for coal for generation of large power, say, for instance, such as is used for running one of the underground electric railways? I find it difficult to get figures, and select the Central London Railway, because it is the only one which I can find has published complete enough details to get at a price per ton.

At the discussion on Mr. Langdon's paper, I heard Mr. Cuningham say, "on the C.L.R. the quantity of coal is 0·5 lb. per ton-mile." From your valuable paper I learn the weight of a train is 150 tons, and the train miles run by C.L.R. 486,004, for an expenditure on coal of £11,094 6s. 4d.

From these figures I deduce that the C.L.R. Co. paid 12s. 9d. per ton for their coal during all the latter half of last year, but your report stated that the directors blamed the *abnormally high price of fuel (12s. 9d. per ton)* for their heavy costs. It would greatly oblige me, and perhaps interest other students who have as much difficulty as I have to get practical information, if you will explain what to me seems as if someone had blundered. Is it I?

Student, I.E.E.

THE RATING OF ELECTRIC LIGHT AND POWER STATIONS.

(*Continued from page* 521.)

Application of the Hypothetical Rent Theory.—Seeing that profits are to be taken into account, we are now in a position to consider the principle which should be adopted in rating an electric supply undertaking. It will be expedient to consider in the first place the case of a private trading company.

Private Undertaking Situated in one Parish.—Assume for the sake of simplicity that the whole installation, *i.e.*, generating station, mains, &c., is situate within one parish. It must also be assumed that there is a hypothetical tenant in possession of the whole concern. In considering what rent he could afford to give, such a tenant would have regard to the profits to be made out of the undertaking. He would have to ascertain the gross receipts for a single year (the question what year is to be considered for this purpose is dealt with hereafter). From the gross receipts he would be entitled to make the following deductions:—(1) Ordinary working expenses; (2) The usual tenant's rates and taxes, which must be deducted, inasmuch as the term "net annual value," as used in the Parochial Assessments Act, 1836, assumes that the tenant has to pay the usual tenant's rates and taxes. Where the entire installation is in one parish this item may conveniently be included in the working expenses. (3) The cost of repairs, insurance and other expenses, if any, necessary to maintain the hereditament in the state to command the rent.

Under the head of insurance, the owners of the station would be entitled to include the premiums paid by them to avoid the risks to which they are exposed by the Workmen's Compensation Act, 1897. Such expenditure obviously tends to keep the premises in a state to command the rent, as it subsitutes a small steady payment for the risk of having to pay large sums by way of damages to the relatives of deceased workmen. The sum which remains, after such statutable deductions have been made, is termed "the net receipts."

Having determined the net receipts, the question arises: What proportion of this amount would the hypothetical tenant be likely to give by way of rent? Or, in other words, what portion of the net receipts constitutes the tenant's share? It is obvious that no tenant would give the whole of the net receipts, for there would then be no margin left for profits and no provision against the risk of embarking his capital upon such an undertaking.

The determination of this hypothetical "rent" is left as a question of fact (R. *v.* Sheffield Gas Company, 1863, 32 L.J.M.C., 169) to the rating authorities, subject to an appeal to the Quarter Sessions, the decision of the latter tribunal being final upon the point. To put the matter in another form, the Assessment Committee have to decide what a tenant ought to reasonably expect by way of profit on his undertaking. Having deducted this amount from the net receipts, a figure remains which is the gross estimated rental which a tenant may be expected to pay where the landlord has undertaken to defray "the cost of repairs, insurance, and other expenses (if any) necessary to maintain the hereditaments in a state to command the rent; for the cost of repairs, renewals, &c., has already been deducted from the tenant's gross receipts.

Having set forth the general principles applicable to the rating of an electric lighting undertaking, it may be useful to consider the various items included in a few examples of a valuation.

Example I.

The ——— Electricity Supply Corporation.

Valuation for Assessment, year ending , 190 .

Receipts—			
Price of electricity	£		
Meter and motor rental	£		
Less bad debts	£		
Gross receipts	£		
Expenditure—			
Coal	£		
Wages	£		
Salaries	£		
	£		
Expenditure—*(Continued)*			
Carried forward	£		
Repairs and maintenance	£		
Repairing, renewing and re-fixing meters	£		
Lighting and repairing public lamps	£		
Rates (ratable value 1s. in the £) ...	£		
Stationery and printing	£		
General establishment charges ...	£		
Law expenses	£		
Total expenditure	£		
Net receipts, carried forward			£

WORKING CAPITAL.

Working expenses (usually estimated at five months' expenditure) ...	£	
Six weeks' stock of coal, calculated on the maximum daily consumption ...	£	
Sundries in stock	£	
Tools and implements, including coal wagons	£	
Office and laboratory furniture ...	£	
Meters on hire and in stock	£	
One quarter's rent	£	
Arc and incandescent lamps for public lighting not including pillars ...	£	
Tenant's capital	£	
Interest on tenant's capital at 5 per cent.	£	
Trade profits on tenant's capital at 10 per cent.	£	
Risks and casualties on tenant's capital at 2½ per cent.	£	
Tenant's share		£
Gross estimated rental		£

STATUTABLE DEDUCTIONS.

Renewals: The sum which, set aside annually and invested at 3 per cent. compound interest, will reproduce £ , the structural value of the buildings, apparatus, fixed plant, and mains at the end of 25 years, their average life	£	
Insurance on £ (being the value of working capital)	£	
		£
Ratable value		£

EXAMPLE II.

The following scheme is set out in Boyle and Humphreys Davies on the Law of Rating:—

VALUATION OF ELECTRIC LIGHTING WORK.

GROSS RECEIPTS.	£ s. d.	£ s. d.
For the year ending		
Sale of current		
„ „ under contract		
Public lighting		
Rental of meters		
Discounts		
Sale of materials, stores, &c.		
Deduct		

WORKING EXPENSES.	£ s. d.	£ s. d.
Generating and Distribution of Electricity:		
Coal and other fuel		
Oil, waste, water, and engine room stores		
Salaries of engineers and officers ...		
Wages at generating and distributing stations		
Miscellaneous expenses		
Management Expenses:		
Directors' remuneration		
Salaries of secretary, clerks, &c. ...		
Stationery and printing		
General establishment charges ...		
Auditors		
Law charges		
Rates in the £ on £ ratable value ...		

OCCUPIER'S SHARE (Tenant's Capital).	£ s. d.	£ s. d.
£ schedule (A)		
Interest on capital employed		
Trade profits		
Risks and casualties		
Income-tax on tenant's profits at thereon		
Repair and maintenance of tenant's chattels		
Gross value		

STATUTABLE DEDUCTIONS.	£ s. d.	£ s. d.
Maintenance and renewal of mains and works		
Insurance		
Allowance for depreciation		
Ratable value		

EXAMPLE III.

The original valuation of the Canterbury Corporation Electric Lighting Works brought out the ratable value at £700. On appeal to the Recorder, this figure was lowered to £370 by the following method:—

VALUATION OF CANTERBURY CORPORATION ELECTRIC SUPPLY UNDERTAKING.

1. Gross receipts of the undertaking			£3,169
2. Deduct working expenses, viz.:—			
Coal and other fuel	£349		
Oil, waste, water and stores	17		
Wages	261		
Attendance public lamps	78		
Management expenses and salaries ...	412		
Rates at 6s. 3d. in the £ on £370	115		
			1,232
3. Net receipts			£1,937
4. Deduct tenant's allowances, viz.:—			
17½ per cent. on tenant's capital of £3,600 [*i.e.*, 10 per cent. for trade profits, 5 per cent. for interest, 2½ per cent. for risks and casualties.] ...			630
5. Gross value			£1,307
6. Deduct statutable allowances, viz.:—			
Landlord's capital:—			
Plant, accumulators, switchboard, mains and lamp pillars	£21,850		
Buildings, exclusive of destructor	5,744		
Total	£27,594		
Repairs, 1 per cent. on £27,594	£276		
Insurance	42		
Depreciation:—			
2·75 per cent on £21,850	600		
0·33 „ „ „ 5,744	19		
			937
7. Ratable value of undertaking			£370

The following notes will serve to explain some of the items referred to in the above examples:—

Under the heading "Receipts" will be included the income of the company from every source, *i.e.*, whether from private consumers or from public authorities. The rent of meters on hire—as distinguished from the price for electricity registered on such meters—must also be included. In the case of undertakers who supply electrical fittings, it is conceived that the profit made by the sale of such fittings would not be included under the heading "Gross Receipts," inasmuch as the sale of such fittings is a source of income which cannot be said to be derived from the hereditament.

(*To be continued.*)

LEGAL.

BRENTFORD URBAN DISTRICT COUNCIL *v.* THE LONDON UNITED TRAMWAYS.

THIS case which came before Mr. Justice Farwell in the Chancery Division on Thursday last week, was an action by the plaintiffs claiming that in accordance with the true construction of the London United Tramways Act of 1898 and 1899, the plaintiffs were not entitled to commence the construction of Tramway No. 7 of the defendants' system on and within the plaintiffs' district until they had complied with the requirements imposed upon them by the provisions of the General Tramway Act of 1870; and for an injunction to restrain the defendants from excavating the soil or interfering with the surface of a certain highway known as the Half Acre, being part of the Boston Road, and from using that road, or any part thereof, for the purposes of a tramway.

Mr. BUTCHER, K.C., in opening the case for the plaintiffs, said that the first point to be decided was whether or no the defendants, before they broke up the road and put in the mains they proposed to lay down, were bound to widen it. It was admitted that the defendants had not yet taken any steps to do that. The second point was whether—assuming the plaintiffs were wrong on the first point—the defendants had given a regular notice before they commenced or endeavoured to break up the streets. The defendants alleged that they were not bound to give any notice at all. This question of notice was not a mere technical matter at all, because he (counsel) should call evidence that along this road which the defendants proposed to break up so as to lay their mains at a certain depth, there were a very considerable number of drains communicating with the main sewer—drains running from the houses on either side of the road into the main sewer. The plaintiffs' evidence was that if the defendants were allowed to go and break up the streets and lay mains to any depth they liked, it might be a very serious matter to the plaintiffs. The notice that the defendants had given the plaintiffs did not give them any information as to what depth the defendants proposed to lay their mains and how they proposed to avoid touching drains and sewers. Those were the points in the case. It appeared from the statement of the learned counsel that in the year 1898 the plaintiffs gave the defendants notice of their intention to oppose the defendants' Bill authorising the construction of the tramway in the district, as they considered it would interfere with their rights. On March 1st, 1898, an agreement was come to between the plaintiffs and the defendants, the effect of which was that the plaintiffs abandoned their opposition to the Bill in consideration of the defendants granting the plaintiffs certain con-

cessions. In substance the provisions of the agreement were inserted in the defendants' special Act. The whole question in dispute turned upon the construction of this agreement and the special Act of the defendant company.

The case for the defendants was that what they were doing in Boston Road was merely laying down an electric cable for the purpose of feeding the lines already constructed, and that this did not form part of the construction of Tramway No. 7 at all, and that such notice as had been served by them upon plaintiffs was a sufficient compliance with the Act of 1870. The defendants further said that their mains were made of such a flexible material that they could easily avoid touching the sewers and drains.

At the conclusion of the arguments, his Lordship, in giving judgment, came to the conclusion that what the defendants were doing in laying mains along the Boston Road was for the purpose of *bonâ fide* supplying electrical power for the purposes of their several authorised tramways running north and south, and although it might be possible to use the electrical energy for the purposes of Tramway No. 7 when completed, the mains were not laid for that purpose. He came to the conclusion that the defendants were quite within their rights in doing what they had done, and that they had on the point as to notice satisfied the requirements of Section 31 of the Act. He thought the plaintiffs' action failed altogether, and must be dismissed with costs.

Mr. Balfour Browne, K.C., and Mr. Buckmaster appeared for the defendants.

Heath *v.* Gascoigne.

This case which came before Mr. Justice Ridley and a common jury, in the King's Bench Division on Wednesday last week, was an action brought by the plaintiff, Mr. Ernest Chas. Heath, an electrician, against the defendant, Mr. H. Gascoigne, the manager of the Avondale Hotel, Dover Street, Piccadilly, for damages for slander.

The plaintiff was in the employ of the Electric Lamp Supply Company, and was engaged in doing work at the Avondale Hotel in November last. His case was that the defendant had to Mr. Day, the manager of the electric company, accused him of having stolen a switch from one part of the hotel, in order to put it up in another. As a matter of fact, the plaintiff had taken a switch from the stillroom staircase, and had put it up in the corridor, and this switch had been charged for as being supplied by the Electric Company, but the plaintiff had put up a new one in the staircase a day or two later. The defendant denied that he had accused the plaintiff of stealing, and in the alternative pleaded privilege, but he admitted that he had charged the plaintiff with improper conduct with regard to the switches.

In the result the jury awarded the plaintiff £40 damages, and judgment was given accordingly.

Mr. Dodd, K.C., and Mr. Moyses appeared for the plaintiff; and Mr. McCall, K.C., and Mr. Sinclair for the defendant.

Barlow Bros. *v.* Jay.

Mr. Justice Lawrence, sitting with a common jury in the King's Bench Division last week, heard this case, which was an action to recover the price of certain electric lighting work done on the defendant's premises, and for damages for breach of a contract to carry out the work. The defence was that the defendant was induced to enter into the contract by reason of misrepresentation on the part of the plaintiffs. The plaintiffs were Messrs. Barlow Bros. and Co., who carried on an electrical business at Shaftesbury Avenue, and the defendant was Robert Jay, a jeweller in Essex Road, Islington.

Mr. Foote, K.C., and Mr. Sinclair Cox appeared for the plaintiffs, and Mr. R. Wallace, K.C., M.P., and Mr. Lush for the defendant.

Mr. Foote said the defendant employed the plaintiffs to do the work, but the defence raised was that the plaintiffs induced him by fraud to enter into a contract by representing to him that the current necessary for the complete lighting of the defendant's premises could be obtained from the Islington Vestry, that the plaintiffs at the time were informed by the engineer to the Vestry that the Vestry was not able to supply the necessary current, and that the plaintiffs fraudulently concealed the said facts from the defendant. According to his instructions a more impudent charge of fraud was never made. Mr. Jay, himself, was negotiating with the Vestry for the electric lighting of his premises long before the plaintiffs were employed. He obtained full information from them, and at the time knew exactly what power they had of providing a proper current. There was no foundation for the allegation that the plaintiffs had ever concealed or represented anything, the real fact being that the defendant wished to get out of payment. The matter began as far back as September, 1899, but before this the defendant had already signed a provisional contract with the Vestry to supply him with light. On September 14th, 1899, at the request of the defendant, they called upon him, gave an estimate of £123, and ultimately it was decided that a contract should be entered into at a price of £1,117 10s., there being extra payment for certain additional work. The installation was to consist of 200 16-c.p. lamps. Before the work was completed, the defendant was informed that the Vestry would be unable to supply the necessary current, and he refused to allow the contract to go on, though the plaintiffs told him he could have 8 instead of 16 c.p. lamps until the Vestry was able to supply more current, when the lamps could be changed.

Evidence was called on behalf of the plaintiffs' case.

Mr. Wallace said the defendant was a tradesman who knew nothing about electricity. Several months before the contract, he went to the Vestry and saw a Mr. Barley, who suggested that he would require 200 16-c.p. lamps. That was entered on a form by Mr. Barley, and the matter there ended. Some months afterwards he consulted plaintiffs as to an installation. They were supplying other people in the neighbourhood, and he asked whether it would be possible to get a sufficient supply of electricity from the Vestry for the purpose. Mr. Barlow told him that he could, and upon that assurance the defendant entered into the contract. It was a fact that other tradesmen were unable to get more than half the supply they required, and the plaintiffs were aware of the state of things, because they were in communication with the Vestry on this very subject. The plaintiffs had not dared to call Mr. Yeaman, the assistant engineer to the Vestry, the one man who could have given the facts as to the communication which passed between him and the plaintiffs. He would himself call Mr. Yeaman, who would say that communications were passing throughout November and December with regard to the supply which would be allowed to Mr. Jay, and that at the time he distinctly told them that the only amount that would be supplied was 200 8-c.p. The plaintiffs, in full possession of that knowledge, went on fitting up the place. Rumours reached Mr. Jay's ears that the required supply would not be obtainable, and he asked the plaintiffs for a further assurance that it would be obtainable, and got them to write to the Vestry. Mr. Yeaman telephoned to Barlow in reply, and found that he was unwilling to let Mr. Jay know the true facts, because he knew the contract would be stopped altogether. It was only when Mr. Yeaman threatened to tell defendant himself that the plaintiff informed him of the true facts, and then Mr. Jay declined to have anything more to do with the matter. Counsel further contended that if the plaintiffs were entitled to payment at all, the work done and materials used were not worth more than £25.

The jury found that the plaintiffs were entitled to the whole of the accounts charged, £90 11s. 9d.

Judgment for the plaintiffs accordingly for that amount.

Maxwell *v.* British Thomson-Houston Company.

At the West Riding Assizes at Leeds on Wednesday last week before Mr. Justice Kennedy, a special jury action was heard in which the plaintiff, Miss Agnes Maxwell, of Halton, sought to recover damages from the British Thomson-Houston Company, Limited, for personal injuries alleged to have been sustained through the negligence of the defendant company's servants.

According to the plaintiff's case, the defendants obtained a contract from the Leeds Corporation for the construction of the electric tramway between Leeds and Headingley. In order to fix the arms of the side poles, the defendants used a derrick, and on June 10th, 1899, a derrick had been left standing near the tramlines in Cookridge Street, the sides of the platform hanging down, with iron rods projecting. On this date the plaintiff was an outside passenger on a horse-car from Headingley to the centre of the city, and as the car was passing the derrick, one of the rods caught her under the chin and threw her backwards. She was rendered unconscious, and had since suffered from apoplectic fits, in fact, her condition was such that she was unable to give evidence. It had been agreed that if the defendants were liable, the plaintiff should receive £250 damages, and accordingly the only question left for decision was as to liability. It appeared that the defendants had sub-let this part of the work to Messrs. Blackwell & Co., and it had been agreed that the question of the liability of the latter to the defendants should be decided before his Lordship in London. On behalf of the defendants, negligence was denied, and it was contended that if there was any negligence it was on the part of the tramcar driver, and also on the part of the sub-contractors.

The jury found that the persons in charge of the trolley were responsible for the accident, by not having taken reasonable care to remove the trolley far enough away from the tramlines.

Mr. Macaskie, for the defendants, held that the persons in charge of the trolley being servants under the sub-contractors, the defendants were not liable.

Mr. Atkinson, for the plaintiff, contended that having by their contract established a duty, the defendants could not get rid of that responsibility by delegating it to another person.

After hearing considerable argument, his Lordship found that the action had been rightly brought, and judgment was accordingly entered for the plaintiff.

[The report of the case of J. Gibbs & Co. *v.* Chloride Electrical Storage Syndicate, appears on another page of this issue.]

THE ROSENTHAL STORAGE BATTERY.

This battery, the invention of Mr. Rosenthal, is the one used by the National Motor Carriage Syndicate in the runs of their "Joel Electro-mobile" from London to Brighton on one charge, and also in the recent severe trials of electrically-propelled carriages at Chislehurst, the results of which were published in our issue of March 1st. It is said to possess some very interesting features, great output for light weight and durability under rough usage on motor cars. It is claimed that the battery will stand heavy over-discharge, and still more remarkable, that although the plates are of the pasted type, they can be charged in a very short time, with a charging current of four or five times the normal or usual rate, without sustaining any permanent injury. The plates have central supporting grids of lead designed to allow free expansion of the paste in every direction during the process of forming

and also when in use afterwards. Fig. 1 shows the grids, which consist of vertical rods having a diamond section, and of interconnecting horizontal bars having a circular section, the positives

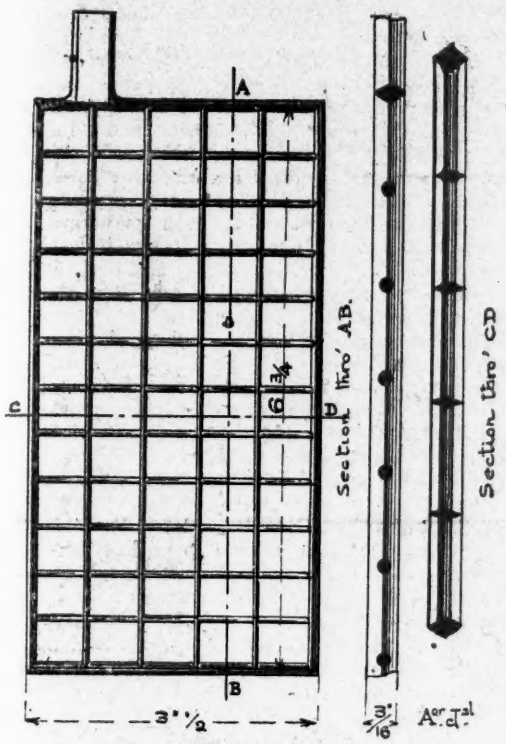


Fig. 1.—Details of Electrodes.

and negatives being similar except in thickness. The paste is a mixture of finely-powdered lead oxide, and a preparation of an inert material, with a solution of specially-treated sulphate salts,

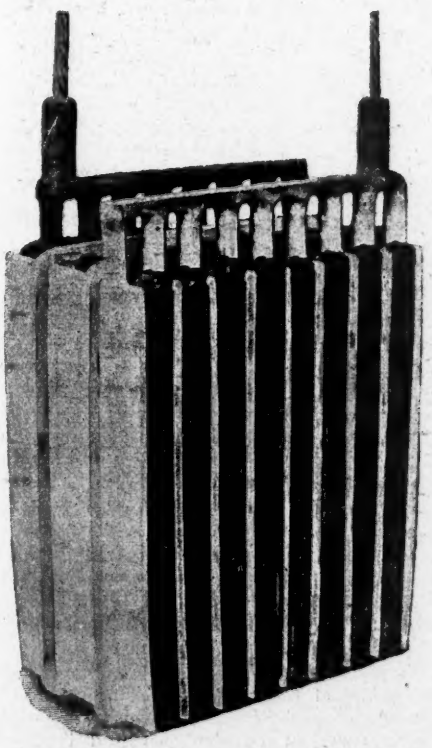


Fig. 2.—Complete Electrodes Removed from Case.

the object being to make a very coherent and yet extremely porous material. Fig. 2 shows the built-up battery (motor-car type). The positives are protected by perforated ebonite plates which press against their surfaces. Ebonite separators are used between the plates, and the sections are held together by rubber bands which also serve the double purpose of springy cushions and of bridge pieces. The plates so built up are inserted into ebonite boxes with the top sides hermetically sealed, but having vent plugs, or valves fitted with rubber nozzles to allow the gas to pass off, otherwise the batteries are "unspillable." Tests of the battery were made by the Standardising Institution at Faraday House, for the National Motor Carriage Syndicate, in 1897, and the results were as follows:—

Test of cell 120 *ampere-hour capacity at* 20 *amperes charge and discharge.*

Charge at 20 amperes for 8 hours = 160 ampere-hours.
Discharge at 20 amperes gave = 143 „ „ (2·02 volt to 1·8 volt.)
Efficiency .. .. .. = 89 per cent.
Weight of plates with terminals and separators wet .. .. = 18·1 lbs.
Watt-hours per lb. of plates (average 1·95 volt.) .. .. = 15·4

Note.—Four of these old-type cells taken from a set of 40 which had been used in motor cars for two years, were tested on January 9th of this year, and all four gave a discharge of 20 amperes for 7 hours = 140 ampere-hours from 2·05 to 1·8 volts.

Tests made March 7th of this year of a newer type of cell of 140 ampere-hours nominal capacity, at 20 amperes charge and discharge.

Charge at 20 amperes for 9 hours = 180 ampere-hours. Acid solution, 1,170 to 1,300.
Discharge at 20 amperes .. = 160 „ „ 2·01 to 1·8 volt.
Efficiency .. .. .. = 88·9 per cent.
Weight of plates with terminals and separators wet .. = 19 lbs.
Weight of complete cell .. = 23½ lbs.
Watt-hours per lb. of plates (average 1·95 volt) .. .. = 16·38.
Watt-hours per lb. of complete cell .. .. = 13·1.

Note.—This cell was taken from a battery of 36 cells, which had been in use for over nine months in a motor car, running over 500 miles on ordinary roads, many times discharged at 60-ampere rate, and at an average discharge taken as 25 amperes.

This battery of 36 cells was used for a run from London to Brighton on October 18th last—average discharge 29 amperes for 5½ hours, a total of 159·5 ampere-hours; the pressure of the battery at rest immediately on arrival at the Brighton Electric Supply Works was taken by the observer, and was found to be 72 volts, or 2 volts per cell. This record of 16·38 watt-hours per lb. of electrode is said to be the highest output ever obtained from a battery in actual work, and, as the recent tests show, without detriment to the plates. An output of 180 ampere-hours can be obtained from these cells in the laboratory showing an efficiency of over 90 per cent. and 19 watt-hours per pound of electrodes—an extraordinary result. One of the cells, of 140 ampere-hour capacity, was taken from the same battery and tested on January 23rd of this year. The charge was started at 10 amperes, and gradually increased during the first 10 minutes to 80 amperes.

1. Charge at 80 amperes for 2½ hours = 200 ampere-hours. Acid solution 1,170 to 1,260.
Discharged „ 20 „ „ 5½ „ = 110 ampere-hours. Volts 2 to 1·75.
2. On January 25th—
Charge at 80 „ „ 2½ „ = 200 „ Acid solution, 1,170 to 1,260.
Discharged „ 20 „ „ 6 „ = 120 ampere-hours. Volts 2 to 1·75.
3. On January 26th—
Charge at 80 „ „ 2½ „ = 200 „ Acid solution, 1,170 to 1,260.
Discharged „ 20 „ „ 6 „ = 120 ampere-hours. Volts 2 to 1·75.
4. On January 29th—
Charge at 80 „ „ 2½ „ = 200 „ Acid solution, 1,170 to 1,260.
Discharged „ 20 „ „ 6 „ = 120 ampere-hours. Volts 2 to 1·75.

These tests were made to ascertain if the cell showed any falling off under a repeated overcharge of exactly the same current, and the results of the discharges were the same in all three later tests. A minute examination of the plates failed to show any signs of disruption. From the tests an efficiency under these abnormal conditions was found of 60 per cent., but it was evident that had the charge of 80 amperes been continued for probably half an hour longer, the specific gravity of the solution would have risen to about 1,300, and the output have been increased to 140 ampere-hours. To ascertain if this cell was damaged by these successive overcharges a test was very recently taken (March 8th), as follows:—

Charge at 20 amperes for 10 hours = 200 ampere-hours and acid solution 1,170 to 1,300.
Discharge at 20 amperes for 8 hours = 160 ampere-hours, volts 2·05 to 1·7.

Note.—This cell had only had one charge and discharge since January 29th, after a rest of over five weeks, and it is noteworthy that the output should be practically as good as ever it was, and this cell proved to be still in first-class working order.

It would seem from the foregoing tests and actual experience in practical use that in the Rosenthal battery a pasted cell with all the advantages of light weight, and, more important still, of durability, has been found that can be charged in a very short time on such occasional use as, say, when on a long run—during a stoppage for lunch—and which will stand excessive overcharge and over-discharge and still remain reliable, and thus fulfil all the necessary conditions of a cell for use with motor cars. Messrs. Joel & Co., who are the manufacturers of these cells for the National Motor Carriage Syndicate, have made tests of them extending over four years, and fully corroborate the tests given in the foregoing. The enormous strides that have been made in storage batteries is evident when it is remembered that 10 years ago a cell of a capacity of 120 ampere-hours weighed 66 lbs., and probably gave an efficiency of 80 per cent., and even then was not durable under rough usage. Now a cell weighing only 23½ lbs. complete, with proved durability, will give 160 ampere-hours at an efficiency of 89 per cent. Such an advantage makes electric automobiles, and, indeed, electric traction generally, more practicable and economical, and opens out a promising vista for the future.

F

THE PART PLAYED BY THE ANTENNA IN WIRELESS TELEGRAPHY.

By E. GUARINI and F. PONCELET.

The part played by the antenna in wireless telegraphy has been interpreted in various ways. In our opinion these interpretations do not agree with the facts observed up to the present. The antenna is of the highest importance in wireless telegraphy, because up to the present it is by its means that the greatest ranges have been attained.

According to M. Broca, the antenna constitutes a concentrator of energy. The greater part of this energy is distributed into space over planes perpendicular to the antenna; the distribution over oblique planes would diminish in proportion to the square of the cosines of the angles which they make with the normal planes. The energy is scattered, however, at the extremity of the antenna, and even entirely escapes when it is terminated in a point.

The antenna is evidently a concentrator of waves, since effects are only obtained at 100 metres with a simple oscillator worked by a powerful coil, whereas with the same apparatus furnished with antennæ, the effects can be observed at 50 kilometres. But the distribution of the energy only takes place over planes normal to the antenna. We will suppose that energy is concentrated by the surface of a straight cylinder; if we observe a distribution of energy outside the space comprised between the two parallel planes passing through the bases of the cylinder, *i.e.*, as M. Broca thinks, a distribution of energy in oblique planes, it is because the bases of this cylinder are not geometrically perpendicular to the axis of the cylinder, and because they present on their circumference parts that are rounded or inclined with regard to the axis of the cylinder. This fact is confirmed by the photograph of waves obtained by M. Tommasina (*Comptes Rendus de l'Académie des Sciences*, May 28th, 1900).

M. Tommasina came to the conclusion that the radiating antenna acts as a capacity, and that its superficial molecules transmit to one another the oscillatory movements produced in the discharges. These movements would be transmitted at the same time to the molecules of the surrounding ether along lines radiating from the wire along an infinitely great number of parallel planes perpendicular to the axis of the wire. *These lines were always normal near their starting point.*

This theory is not weakened by M. Lecarme's experiment in a free balloon, in which the antennæ were at a given moment apparently in a line with one another, their extremities being separated by several hundred metres; in reality, these antennæ could not have been geometrically in a line with one another, nor geometrically rectilinear, as a perceptible wind was blowing during the experiment; parts of the two antennæ might therefore have been parallel. Moreover, the radiations from the oscillator, which are spherical, may have reached the receiving antenna either directly or by reflection from the earth; it must also be added that conducting bodies in the vicinity of the transmitting station have acted as fresh radiators under the influence of radiations emitted by the oscillator of the transmitting antenna (*Comptes Rendus*, Vol. cxxxi., No. 13, pp. 540—541).

As to the phenomenon said to occur at the extremity of the antenna, it does not seem to me admissible; if we send water at a certain pressure into an india-rubber tube ending in a point, the pressure will be exercised not only at the extremity, but also on the sides of the tube.

Moreover, if the pointed extremity of the antenna were the sole starting-point of the radiations into space, we ought to obtain the same effects by placing at the summit of the antenna a simple ball oscillator, which is not borne out by experiment. M. Broca calls attention to the fact that vertical antennæ are more favourable than horizontal, but he puts forward no theory based on this fact; we shall return to this point presently.

According to Messrs. Blondel and Ferrié the antenna connected to earth forms a more powerful oscillator than the ordinary oscillator; every point of the surrounding space is the seat of an electric force normal to the antenna and to the surface of the earth, and of a circular magnetic force having its centre on the antenna. The electric density is greater at the surface of the earth. The receiving antenna is only influenced by the magnetic force; the farther the antenna is away from the earth, the fewer lines of magnetic force it meets; for an equal length it cuts the fewer in proportion as it is the further removed from the earth. In other words, the effect is greater at the surface of the earth than at a certain height (International Congress of Electricity, Paris, 1900). This theory seems to us at certain points to contradict both itself and M. Blondel's theory, as put forward by M. Broca at the French Physical Society, May 15th, 1899. In fact, it is very difficult to conceive lines of electric force at the same time normal to the vertical antenna and to the earth. Moreover, if the circular lines of magnetic force are in planes normal to the antenna (M. Blondel's theory), how can they glide along the earth (Messrs. Blondel and Ferrié's theory)?

The strata of ether at the surface of the earth possessing a maximum electrical density may be compared to a kind of electric mist, rising at the most to a height equal to the height of the transmitting antenna. We can easily understand that in this case the receiving antenna is more influenced when it is entirely plunged in this mist than when only partly. In our opinion this fact is proved, but in quite another way, as we shall presently show.

"Certain writers," say MM. Blondel and Ferrié in their report, "have believed it possible to produce electrostatic capacities between the antennæ; nevertheless, it is easy to see that the effect produced would decrease in inverse proportion to the cube of the distance, and then disappear, which is contrary to what is indicated by experimental results." Lastly, according to M. Marconi, the maximum effect is obtained between two equal and parallel antennæ.

In our opinion, the part played by the antenna is deduced from the mode of propagation of the electro-magnetic wave as we conceive it.

Propagation of the Electro-Magnetic Disturbances of the Ether.

If a wire is traversed by a variable current (a weak current at high tension, that is to say, a current with a weak magnetic field, as is the case in wireless telegraphy), the effect is the same as if the current were confined to the surface of the conductor. In the limit, in the case of undulations at high frequency, the surface of the conductor alone is affected. (Bjerknes's experiments.)

This current may be utilised in the form of work L, and by the Joule effect i; a part e of the energy E of the variable current is transformed into electro-magnetic waves, which are dissipated into space, *i.e.* :—

$$E = e + i + L.$$

If L and i were *nil*, the whole of the energy would be dissipated in space.

The radiation of the electro-magnetic waves (in the case of variable currents of low intensity and high tension, the principal effect is electric, the magnetic effect being merely secondary) is perpendicular to the surface of the wire, the only one, moreover, concerned in this phenomenon. At each point of the ray of propagation there exists an electric force and a magnetic force. The electric force is perpendicular to this ray and parallel to the direction of the variable current, *i.e.*, of the wire. The magnetic force is perpendicular both to the ray of propagation and to the electric force, *i.e.*, it is at the intersection of the two planes, one of which is normal and the other parallel to the surface of the wire.

Consequently a cylindrical wire 1 metre high, for instance, produces an ethereal disturbance in a space limited by the two perpendicular planes at the extremities of the wire. When the section of the conductor is polygonal, the disturbance takes place opposite each surface of the prismatic wire, within sectors limited on the one hand by the planes perpendicular to the wire, and passing through its extremities, and on the other by the planes passing through the edges of the prism, and normal to the surfaces of the latter.

If at a point of the ray of propagation there is a superficial conducting element (receiving antenna), we get a maximum effect of induction (electric) in this element, when

it is tangential to the planes of the electric and magnetic forces. For this, in the case in which two antennæ are two right cylinders, the effects are at the maximum when each is entirely comprised—supposing them to be equal—within the two planes passing through the bases of the other. In the case of two antennæ with square and equal sections, the receiving antenna should not only be comprised within the above-mentioned sectors, but should also be parallel to the opposite face of the transmitting antenna.

Part Played by the Antenna.—The union of the antenna with the oscillator enables the distance of transmission to be increased.

1. By its capacity, C, which at an equal potential, V, increases the energy of discharge $\frac{1}{2} C V^2$.

2. The oscillator radiates the energy into space spherically, whereas the antenna—if it is cylindrical—distributes this energy in planes normal to its direction; the oscillator alone does not produce any effect beyond 100 metres, whereas if furnished with an antenna—supposing that the receiver is also furnished with one—it enables a distance of 50 km. to be attained.

3. By increasing the ratio of the surface of the antenna to that of the oscillator, *i.e.*, by increasing the length of the antenna, we augment the energy distributed in planes normal to its direction to the detriment of the energy radiated spherically by the oscillator.

4. The transmitting antenna is the source of an electromagnetic disturbance which is propagated in the space limited by the two planes perpendicular to itself, and passing through its extremities, the rays of propagation being normal to the surface of the antenna. The receiving antenna is influenced more or less according to whether it is entirely or only partly within this space; the effect is *nil* if it is entirely outside the space.

If the horizontal antennæ have not given good results, it is because they have not at the same time been made parallel, and been comprised entirely within the normal planes passing through the extremities of one, conditions which are fulfilled at any rate in part with the vertical antennæ.

Conclusions.—Instead of the long vertical antennæ employed up to the present, it is only necessary to arrange small antennæ (about 1 metre in length), provided or not with Hertzian reflectors, arranged parallel in the two corresponding stations, and in such a position as to be comprised within the normal planes passing through their extremities. It does not matter whether they are horizontal, vertical, or oblique, so long as the above-mentioned conditions are fulfilled. If between the two stations there are any obstacles such as the curvature of the earth, metallic objects, houses, trees, &c., which absorb the radiations, the distance of transmission will be diminished, and communication may even be stopped. In this case the two antennæ must be raised so as to be above any obstacles. At sea, the curvature of the earth has less influence, as the electric waves pass through the water, and in this case the absorption depends on the quantity of salt in the water. The curvature of the earth only intercepts wireless telegraphy at sea at long distances, when the electric waves come in contact with the bottom of the sea.

BUSINESS NOTES.

Automobile Exhibition.—The annual Automobile Club Exhibition will be opened at the Agricultural Hall, Islington, the first Saturday in May, and, it is stated, will show a remarkable advance on its predecessors. The business directors of the show are Messrs. Cordingley & Co., of Shoe Lane, E.C.

Bankruptcy Proceedings.—Notice of intended dividend is given by the liqudator (Mr. G. S. Barnes) of the Electric Exploitation Company, Limited.

Books Received.—"Twentieth Century Inventions," by G. Sutherland. London: Longmans, Green & Co. 1901. 4s. 6d. net.

"Science Abstracts" for March 25th. London: E. & F. N. Spon, Limited. 2s. net.

"The Application of Electric Motors to Machine Driving," by A. Stewart. London: S. Rentell & Co., Limited. 1900. 1s.

Liquidation.—The Bute Electrical Manufacturing Company, of Cardiff, is winding up voluntarily, with Mr. R. Leyshon, 12, Mount Stuart Square, Cardiff, as liquidator.

Carroll v. New British Incandescent Electric Lamp Company.—This was a motion made before Mr. Justice Buckley in the Chancery Division of the High Court of Justice on Tuesday, for the appointment of a receiver in the case of the New British Incandescent Electric Lamp Company. Counsel stated that the applicant was a holder of debenture shares in the company. The debentures were in sums of £100, £50, and £25. In the affidavit of the plaintiff, counsel said there was the statement, which was not contradicted, that on November 15th, 1900, the defendant company executed a mortgage on leasehold premises at Willesden Junction in favour of Messrs. Fly & Everitt, and such mortgage took priority of debentures. These two gentlemen had had to go to the Police Court very recently. The affairs of the company had suffered very much in consequence of the way in which it had been conducted. His Lordship granted the application.

Catalogues and Lists.—Messrs. Flather & Co., of Leeds, send us their new lists of standard motors and generators Specifications are given of multipolar continuous-current machines, and open type C.C. motors.

The Berliner Telephone Manufacturing Company, of 117, Queen Victoria Street, E.C., send us a copy of their leaflet, "No. 51," describing their "Marvel," "Elite," "Eclipse" and "Premier," twentieth-century telephones for private houses, hotels and offices. Diagrams of connections are included.

The General Compressed Air House Cleaning Company, of St. Louis, have issued a very neat and fully illustrated booklet, in which they describe their dustless method of compressed-air house cleaning.

Mr. A. J. Wright, of Upper Street, N., sends us illustrated trade lists of his telephones, electric bells, dynamos, electric light accessories and novelties.

Messrs. Falk, Stadelmann & Co., Limited, of Farringdon Road, E.C., have brought out a "new season's" catalogue of their electric bells and telephones A variety of bells, indicators, pushes and pulls, and complete sets, are shown and priced, also telephone transmitters and receivers, wall and table apparatus, and parts and tools used in connection therewith.

From Accumulator Industries, Limited, of Bloomsbury, W.C., we have received a catalogue of the "Cupron-Element" constant-current primary battery, for which they are sole licensees for Great Britain, &c.

Claim for Damages Dismissed.—At the Glasgow Court of Session on March 26th, before the Lord Justice Clerk and a jury, Thomas Burke, labourer, claimed against Macartney, M'Elroy and Co., Limited, contractors, for £2,000 as damages for injuries. He was in the employment of the defenders, who were the contractors for the erection of the standards for the support of the electric trolley wires for the Glasgow Corporation tramways. A travelling crane was used for the work. On June 27th this crane was being taken along Crown Street; the left front wheel of the bogie came off, and the crane fell sideways on to the roadway. The pursuer and other workmen were, as is the usual custom, sitting upon the bogie. As it fell the handle of the crane caught the pursuer's left leg and pinned it to the ground. He sustained two compound fractures of the leg, which it was necessary to amputate. It was averred that the wheel came off because a bolt had broken off some days before. The defenders said that the workmen had no right to be on the bogie, that they were ordered off it by one of the superintendents, but it was believed that as soon as he was out of sight they got on again, and they believed that it was the extra weight of the men which caused the wheel to collapse. The jury returned a verdict for the defenders.

Condensing Plants.—Among recent orders secured by the Wheeler Condenser and Engineering Company for cooling tower and condensing plants are:—Cooling tower and condenser for the Warsop Colliery, of a capacity equal to 3,000 H.P.; cooling tower and condenser for the Blyth electric station, Woolwich electric station, Cape Town Refrigerating Company, Bradford Union Board of Guardians, also for a third cooling tower for the power station, Croydon. The Wheeler Company have also received duplicate orders for the Belfast and Brighton condensing plants, and, among others, have received orders for condensing plant for the Folkestone, Barnes, and Chatham power stations.

Extension of Patent.—The application of the British Aluminium Company for an extension of term under Patent No. 7,426 of 1897 granted to A. C. Henderson for "An improved process for the preparation of aluminium by electrolysis," is to be heard on Wednesday, May 15th, by the Judicial Committee of the Privy Council.

Installation Work.—Messrs. G. H. Woods & Co., of Blackburn, are largely increasing the electrical contracting business. Among recent work carried out is a 3,000-light plant at Nottingham Workhouse, including three combined Willans-Laurence-Scott sets (two 110-KW. and one 30-KW.). For the Grecian Street Schools in Salford they have put down a gas-driven (two National) installation, and in Scotland a number of country house lighting plants. At the present moment they are installing a complete plant for motor driving at the new printing offices of the *Darwen Gazette*, each machine being driven by a separate motor through raw-hide pinions.

Mine Indicator.—We understand that during last Thursday's meeting of the Institution of Electrical Engineers, through a slip, the impression was created that the coal mine gas indicator on exhibition in the room was the property of the Sussmann Electric Miners' Company. Mr. F. J. Turquand, part inventor, asks us to state the indicator is not, and never has been, connected with the above company. It is known and patented as "Prested's indicator," and the sole address is 44, Brecknock Road, N.W.

Mysore Mines and Electricity.—In his speech to the shareholders of the Nundydroog Company last week Captain McTaggart referred to the project for supplying electrical power from the Cauvery Falls to the Kolar goldfields. The undertaking, he said, owed its initiative to the enlightened policy of the Mysore Government, and he was pleased to say that those in authority stated that they had no doubt of the success of the scheme. The arrangement with the Mysore Government provided for supplying 4,000 H.P. in the first place, and until the experiment had been thoroughly tested it had been decided not to apply electrical power to any but the non-vital portions of the company's machinery. There would not be much saving to the companies on the field for the first year, as the Mysore Government wanted some recoupment, by way of interest at all events, on their large outlay, which was roughly estimated at £300,000 for the first 4,000 H.P. and £200,000 for the second 4,000 H.P. After the first five years the cost of the power to the companies would be £10 per horse-power per annum. In the first year the cost would be £29, in the second, third, and fourth year £18, and in the fifth year a sum not to exceed £24. The cost of steam per horse-power per annum was £30.

Spon's Price Book.—We have received a copy of the 1901 issue of "Spon's Architects' and Builders' Price Book." We have no doubt the book is of great service in the preparation of buildings' specifications and estimates. There is a short section at the end devoted to electric lighting. Fire risk rules and specimen specifications for the wiring of houses in London and in country places are given, also some prices of wires, lamps, fittings and so on. Rules relating to lightning conductors are also included.

Trade Announcement.—Mr. J. E. Austin, electric light engineer, has removed from York Place, Baker Street, W., to larger offices at 40, Upper Baker Street, W.

Train Lighting.—The trains which are now running over the section of the Trans-Siberian from Moscow to Irkutsk, says the *Straits Budget*, are provided with a complete electric system which serves for the lighting and heating of the cars, as well as for the water and milk heaters in the dining car. In the baggage car has been placed an installation consisting of a boiler, a steam turbine, and a dynamo of 5 H.P., which gives the current at a pressure of 65 volts; the plant is under the supervision of an engineer appointed for the purpose. Under one of the cars is disposed a battery of accumulators, which assures the lighting for four hours in case an accident should happen to the dynamo plant, and the latter may be stopped during the night when only a few lamps are in use. Electric cigar-lighters are placed in each compartment.

ELECTRIC LIGHT AND POWER NOTES.

Arbroath.—A meeting of ratepayers has called for a plebiscite on the question of municipal *versus* company electricity supply.

Austria.—It is proposed to establish a large central electric lighting station at Marburg, utilising the water-power of the River Drau.

Belfast.—A L.G.B. inquiry was held last week by Mr. P. C. Cowan into the application of the Belfast Corporation for leave to borrow £95,000 for extensions of the electricity works and mains.

Mr. V. A. H. M'Cowen, city electrical engineer, stated that the plant at present installed was capable of supplying 100,000 8-C.P. lamps; there would probably be 110,000 lamps connected by the end of the year, and 150,000 at the end of 1902. Motors account for 660 H.P. included in the above, and one firm is negotiating for 1,000 H.P.

An explosion, which resulted in the smashing of the cover of a manhole, occurred last week.

Cleckheaton.—Col. Durnford, R.E., L.G.B. inspector, held an inquiry on March 29th into an application by the U.D.C. for sanction to borrow £25,000 for electric lighting purposes and the provision of a refuse destructor, and £120 for the purchase of land for the purpose of a depôt. It was stated that there was a general desire on the part of residents for the electric light, and that it is proposed to supply energy to the British Electric Traction Company, who are about to construct tramways in the district.

Dewsbury.—The Corporation is about to apply to the B. of T. for sanction to supply electrical energy at a pressure of 440 volts to motors to be erected by the Dewsbury Co-operative Society.

Canada.—From statistics quoted by *Commercial Intelligence*, it appears that striking progress has taken place in electric lighting in Canada during the past ten years. In 1891 there were 80 electricity supply undertakings, in 1900, 297. Last year there were in all 807,772 lamps connected. The Royal Electric Light Company, of Montreal, supplies 78,762 incandescent and 1,805 arc lamps, while the Toronto and Ottawa companies have almost as large connections.

Derby.—The T.C. has fixed the charge for motive power, in cases where motor consumers use the maximum demand for an average of over 50 hours per week, at 1½d. per unit.

Electrical Works on the Continent.—The following table, showing the cost of electrical works in different cities on the Continent, and compiled from figures supplied by the American Consul at Amsterdam, recently appeared in the *Financial Times*:—

City.	Opening of electric works.	Horse-power inclusive of reserve.	Total cost.	Cost per horse-power.
			Dols.	Dols.
Vienna	Nov., 1890	11,500	3,015,000	262
Hamburg	Dec., 1891 / Nov., 1895	3,600 / 7,200	3,088,401	286
Frankfort	Oct., 1894	4,500	934,269	207
Dresden	Dec., 1895	3,840	830,481	216
Buda-Pesth	Oct., 1893	4,500	1,326,310	294
Leipzig	Sept., 1895	3,000	804,042	264
Nuremberg	May, 1896	4,000	739,087	185
Cologne	Oct., 1891	2,750	649,324	236
Stuttgart	May, 1891	2,200	727,861	331
Hanover	Mar., 1891	2,800	750,855	268
Christiania	Dec., 1892	1,900	437,082	230
Darmstadt	Mar., 1889	1,575	344,797	219
Chemnitz	July, 1894	1,800	489,804	273
Amsterdam Electric	July, 1892	3,100	1,033,414	333
Municipal Electric works ..	—	3,000	869,124	290

Germany.—According to the annual report of the Industrial and Commercial Union of Berlin, the number of electric power stations in Germany is continually increasing. On March 1st, 1900, there were in Germany 652 central stations, with an output of 25,000 KW.—63 per cent. for lighting, and 37 per cent. for motive power. At October 1st last year, the number had grown to 712, representing an increase of 60 factories in six months. In this connection it is remarkable that the large majority of these new installations were for the development of motive power, and in spite of the growth of electrical power stations in Germany, electric light is not yet within the reach of the better middle classes. This is the result of the system of tariff at present employed, by which the cost of a lamp per hour is the same for the consumer who burns several lamps for a short period as for the one who uses few lamps for a long period.

Keighley. — The electricity supply undertaking is approaching completion, and public supply commenced on the 1st inst.

Llandudno.—The U.D.C. intend to make application to the L.G.B. for sanction to borrow £1,027 in order to lay down a new feeder from the works to South Parade.

London.—The *Times* says that "a curious state of affairs has arisen in the City owing to the recent decision in the Court of Appeal regarding the invalidity of certain contracts that were entered into some years ago between the late Commissioners of Sewers and the City of London Electric Lighting Company. The secretary to the company has addressed a letter to the Corporation pointing out that under the recent decision the contracts for the central and western districts are null and void, the consequence being that those agreements between the company and the Corporation as to the supply of electrical current have ceased to exist. In the circumstances the company ask whether the Corporation wishes the public supply continued, and suggest that a small committee should be appointed by the Corporation to discuss the terms for its continuance."

The L.C.C. has agreed to lend the Hackney Borough Council £30,000 for electric lighting purposes, and the Hammersmith Borough Council £13,530 for the same purpose.

Newport.—Colonel Luard held an inquiry last week on behalf of the L.G.B. into an application by the Corporation for sanction to borrow a further sum of £28,000 for electric lighting.

Russia.—The Allgemeinen Elektricitäts-Gesellschaft has secured the contract (at 300,000 roubles) for the lighting and transmission plant in connection with the new maritime installations of the Isle of Gutuewski, at St. Petersburg. The central power station will be composed of several dynamos at continuous current of 850 H.P., and a battery of accumulators of 1,000 ampere-hours; whilst for the lighting of the port, there will be 116 arc lamps and 300 incandescents.

Shannon Power Scheme.—A conference was held in Limerick on Saturday last to consider the Shannon electrical power scheme. The promoters of the scheme proposed spending £300,000 in the neighbourhood of Limerick. The Shannon is admirably adapted for the purpose, and if the Bill passes Parliament it will bestow great benefits upon the district. It was pointed out that electricity was absolutely indispensable for the manufacture of artificial manures, which were largely used by the farmers, and bought at a high price, and if this scheme were carried through it would help to greatly lower the cost of such manure. A resolution was passed in favour of the scheme, but at the same time providing for the safeguarding of the Fishery interests.

Silsden (Yorks.).—The Council will have the question of lighting under consideration at an early date, and electric lighting seems likely to meet with favour.

Twickenham.—Messrs. Edmundson's Electricity Corporation have acquired a site, with the approval of the D.C., for the purpose of erecting a generating station.

Worksop.—The U.D.C. has decided to charge 6d. per unit for electricity used for lighting, and 2d. for power, with 5 per cent. discount for cash payments. The Council is spending £15,000 on electric lighting works within the district.

Yorkshire Power Schemes.—The Halifax Chamber of Commerce considers that both companies charge too dearly, but, of the two, favours the South Yorkshire Bill. The Leeds Chamber of Commerce, after receiving a deputation from the Yorkshire company, passed a resolution approving the Bill. A conference of representatives of local authorities in the West Riding received a deputation from the South Yorkshire company last week. Mr. Clirehugh, engineer to the company, explained the scheme.

The Huddersfield Chamber of Commerce has resolved that "it is desirable, in the interests of the commerce and industry of Huddersfield and the locality, that the power sought by the Yorkshire Electric Power Bill should be granted by Parliament."

A joint conference of the Guiseley, Yeadon, and Rawdon D.C.s and Menston P.C. was held at Guiseley last week to consider the Yorkshire Electric Power Company's Bill. Since the previous conference the promoters of the Bill had agreed to important amendments, and the delegates decided to report in favour of the Bill.

ELECTRIC TRACTION NOTES.

Bilston.—At a meeting of the U.D.C. last week, Councillor J. W. Sankey stated that the terms the Council had secured from the British Electric Traction Company, as a result of the company acquiring the tramlines in the Council's district, were a line from Bilston to Willenhall, a line from the Fighting Cocks in Parkfield Road to Bilston, a line from Bilston to Bradley, a line from the Bull's Head into Ettingshall, substantial street improvements, and through communication with the South Staffordshire system, which consisted of 50 or 60 miles of line. Councillor Sankey added that unless the Wolverhampton people hurried up, electric traction cars would be running from Bilston to the boundary of that borough before the Corporation were ready to meet them.

Birkenhead.—During the four weeks ending Sunday of last week, 162,728 passengers were carried on the New Ferry route of the Birkenhead electric tramways, the receipts being £788 17s. 4d. The total number of passengers carried since the opening of this route has been 276,337, and the receipts £1,339 8s. 11d. The Finance Committee purpose borrowing £109,000 from the Prudential Assurance Company, Limited, to defray in part the cost of constructing the tramways, the money to be repaid by ten equal yearly instalments of principal and interest at the rate of £3 10s. per cent. per annum.

Blackburn.—A serious accident happened on the Blackburn to Darwen tramline on Wednesday night last week. At a point near the Blackburn boundary two cars met on an interlacing line, and collided with great force, 10 persons suffering injuries of varying severity. The cause of the disaster is not yet fully explained, but it is officially stated that the Blackburn car was in charge of a regular driver who had a learner with him; that the driver's attention was momentarily distracted from the look-out, and that when he looked ahead his car had over-run the main line on to the interlacing metals, and the smash was unavoidable. It is also officially stated that contrary to regulations, two off-duty conductors were with the driver of the Darwen car when the collision occurred.

Dudley.—The Tramway Committee have instructed Mr. R. P. Wilson, electrical engineer, to consider a scheme to be laid before the Committee for constructing a line under the Light Railways Act through Dixon's Green to Rowley Regis.

Electrical Tramways in North of England.—Electrical tramways are becoming increasingly popular in the extreme North of England, for at the present moment there are electrical systems being laid in Newcastle-on-Tyne, Gateshead-on-Tyne, and Tynemouth; South Shields is also considering the matter, while Tynemouth, it may be mentioned, has already got its system for the most part under way. At last week's meeting of the Sunderland Rural District Council the British Electric Traction Company submitted a plan showing a proposed line of tramways from the Sunderland borough boundary through Whitburn to South Shields, a distance of about 8 miles, and they asked for the Council's sanction to that part of the scheme which was in the Council's area. This sanction was formally given. The route would be a great public convenience, as there is no means of communication with the places mentioned which is at all adequate to the needs of the places. There is an irregular train service from South Shields to Marsden, a village midway between the latter place and Whitburn, but this is of little practical use as a means of communication on this part of the North-East Coast, and all the adjacent villages are isolated. The trams would be a very welcome means, too, of reaching the famous Marsden Grotto either from the South or the North. There is a considerable population in the district.

Georgetown (British Guiana).—The *Times* correspondent at Georgetown, writing on February 28th, says:—"An electric tramway system over ten miles in length, and constructed on the most modern methods, has just been opened for traffic in this city, and is receiving an enormous patronage. Hitherto the only tramways in the town were about a mile of line, the cars being drawn by mules. Some years ago, however, on a visit of Mr. W. B. Chapman, an enterprising Canadian financier, who may be called the pioneer of electric locomotion in the West Indies, to the town, the idea was mooted of introducing an electric tramway service. The success of a syndicate formed in Jamaica by this gentleman encouraged the proposal to try a similar experiment in Georgetown, and ultimately a strong Canadian company was formed for the purpose with Sir William Van Horne as chairman. The property of the Georgetown Tramways Company was purchased by the Demerara Electric Company, the name of the new company, which later also purchased the Electric Lighting and Power Company, and obtained a license defining its powers and authorising it to provide electricity for public and private purposes. Some difficulty was experienced in getting the requisite material, but the actual work of construction was rapidly got through in the summer of last year. A difficulty arose as to the wires of the new service—the overhead or trolley system having been adopted—deranging the telegraph and telephone services of the city, but this was also got over. The cost of the service was originally estimated at $20,000 per mile, but it was found to be more expensive than was anticipated, and it is now believed to be not less than $25,000 per mile, or about $250,000 for the whole service. The equipment consists of 14 motor cars, and the fare is charged on the Canadian principle—namely, 5 c. for being taken to any place over the whole system, a reduction of 1 c. per ticket being made when three tickets are purchased at the same time. The lines were run over by his Excellency Sir Walter Sendall, and subsequently by the Mayor and other officials of the Corporation."

Glasgow.—It is stated that the main engines at Pinkston generating station are to be running on April 6th, while two routes, Crosshill to Overnewtown and Dalmarnock to Whiteinch, are to commence running on April 25th.

Hayling Island.—On Thursday last week, the Earl of Jersey and Col. Bougher, Light Railway Commissioners, conducted an inquiry into an application for powers to construct a light railway along the south side of Hayling, to commence at Sangstone Harbour ferry, and to extend to the coastguard station. Mr. Bassett Hopkins, counsel for the promoters, said that it was proposed to use electricity as the motive power of the scheme, and the overhead wire system was favoured as the most suitable. Mr. Russell, of London, engineer to the scheme, gave evidence in its favour. Mr. J. M. Hewitt, consulting engineer to various tramway companies, said the line was expected to carry 34,000 people in the course of the year, and the charge would be 1d. per mile. Mr. Skewes-Cox, M.P., one of the promoters, and other witnesses, gave evidence to the effect that the railway would improve and develop the island. The opposition on behalf of landowners was led by Mr. Boyle, K.C., who, in the course of the inquiry, remarked that the railway would start from nowhere, end at nowhere, and cut off the whole of the sea front of the island. At the close of the case for the promoters, Lord Jersey said there was no evidence to prove that the undertaking was a public necessity for the inhabitants of Hayling, so it was no good to continue the proceedings. The inquiry was therefore abandoned without the case for the opposition being entered upon.

Light Railways.—In the House of Commons on 1st inst., Mr. G. Balfour introduced a Bill to continue and amend the Light Railways Act, 1896.

Liverpool.—Another new cross-city tramway route has been opened at Liverpool. The route is from Spellow Lane, in the northern part of the city, to Princes Road, at the south end.

Nottingham.—In consequence of the construction of the new electric tramways in the Nottingham Great Market Place, the city engineer has, under the direction of the Markets and Fairs Committee of the Corporation, prepared a plan for the re-arrangement of the Market Place, at an estimated cost of £4,500.

Richmond (Surrey).—At the last meeting of the T.C. an agreement was sanctioned with the London United Tramways Company, the principal headings being:—

1. The company will not adopt the overhead trolley system in the borough, but some other system approved by the Corporation.
2. The company agree to the retention of the purchase clause. If Richmond should not exercise the option to purchase at the end of 25 years or at subsequent septennial periods, Barnes may purchase the tramways in both Richmond and Barnes, or the Surrey County Council may purchase them.
3. The company to pay a wayleave of £500 yearly.
4. The maximum fare within the borough to be 1d., and ½d. for workmen.
5. The fare to Hammersmith or Putney not to exceed 2d.
6. The company to pave and maintain the tramway area with approved wood blocks.
7. No further extension without the Council's consent.
8. Street widenings at an estimated cost of £30,000 to the company.

The Bill came before the Examiner of Private Bills on Monday.

Siam.—The Bangkok Tramways Company, Limited, and the Siam Electricity Company, Limited, have submitted a proposal for amalgamation to the Siamese Government. In the event of approval, which is already a foregone conclusion, the new company would build a new line from Bangkok to the suburb of Sam-Sen,

and renew the old system which was laid out in 1887 for animal traction. The necessary rails for the new system are estimated to cost 150,000 ticaux (£9,000).

South Africa.—Notice is given of the intention of the Cape Electric Tramway, Limited, to apply during the next ensuing session of the Cape Parliament to introduce a Bill amending the Metropolitan and Suburban Railways Act of 1889 in such manner as to empower the present owners of the Sea Point Railway to convert the line into an electric railway, with single or double line as may be required. It is intended to adopt the overhead wire system, and the whole line of route will be fenced in. The stations as they at present exist will be utilised, and passengers will board or alight from the cars only at such places.

Southport.—The heavy snow which fell on Friday afternoon last caused the fall of several overhead wires in Southport. In London Street, near the Post Office, a pole broke, allowing wires to fall. In St. Luke's Road, also, a pole, bearing about 50 wires, fell, causing several of the wires to fall across the track of the electric tramway. The guard wires, however, prevented contact with the trolley wires. The telephonic service was suspended, and shortly after six o'clock the electric car service was stopped in order to avoid any risks through wires which had fallen over the tracks.

Spain.—Plans are being prepared in respect of a projected electric railway between Compostela and Curtis, which would place the City of Santiago (Coruna province) in connection with the Northern of Spain Railway.

Thanet.—The Board of Trade inspected the Isle of Thanet Light Railways (Electric) Limited, undertaking last Friday. Hopes were entertained that the service might be available for the public by Easter.

Twickenham.—The D.C. instructed their clerk carefully to watch the progress of the Parliamentary Bill of the London United Tramways Company, notwithstanding that the company have withdrawn their proposed lines in the district; it having been pointed out that the L.U.T. still propose to acquire land in Twickenham for possible street widenings.

Underground Railways.—On 29th ult., before the Standing Orders Committee of the House of Lords, the West and South London Junction Railway Bill, which seeks to authorise an electrical underground railway, about five miles in length, from Paddington to Kennington Park, joining up the termini of the Great Western, Central London, London Brighton and South Coast, and London and South-Western Railways, was reported by the examiner as having failed to comply with Standing Orders, notice not having been given to the Duke of Northumberland, Lord Iveagh, and the Hon. W. F. D. Smith, owners of property in Grosvenor Place, within the line of deviation. The Committee ultimately decided to allow the Bill to proceed on the condition that the protective clause offered by the promoters should be inserted with the addition of the words, "subsoil in such cellars or vaults."

Wallasey.—On Saturday morning the D.C. took over the tramways from the local company. The D.C. worked the service for the first time, under their own control, on Sunday last.

West London.—Colonel Yorke last Saturday morning made the final Board of Trade inspection of the lines of the London United Tramways Company from Shepherd's Bush to Acton and Goldhawk Road, and Hammersmith to Kew Bridge. The car traversed the whole system at present adapted for electrical traction, except the Brentford section. The surveyors of the various districts through which the lines run—Hammersmith, Acton, Chiswick and Brentford (a small piece of the line near Kew Bridge being in the jurisdiction of the last named)—expressed themselves as highly satisfied, and pressed for an early opening of the electrical equipment. The *Times* states that "when that consummation is reached now depends on the action of the Kew authorities, who, however, are believed to be giving the situation their sympathetic consideration."

TELEGRAPH AND TELEPHONE NOTES.

Cable Rates to India.—A telegram received in London from Calcutta states that the Government of India has agreed to a reduction of the cable charges from India to London to 2s. 6d. per word. The reduction, amounting to 1s. 6d. per word, has been assisted by the representations of Sir Edward Sassoon, M.P., and Mr. Henniker Heaton, M.P. It is said that the change will come into effect almost immediately.

Imperial Telegraphs.—A meeting of the Parliamentary group known as the Imperial Telegraph Communication Committee was held at the House of Commons on 29th ult. Sir Edward Sassoon, who presided, referred to the progress which had been made as the result of the Committee's work during the past year, laying especial stress upon the fact that the Australian cable rate had been reduced from 4s. 9d. to 3s. 6d. per word and the South African rate from 5s. to 4s. He also spoke very hopefully concerning the prospect of an early reduction to 6d. per word of the rates for messages to America and Canada. After some discussion, it was agreed that Mr. Chamberlain should be asked to receive a deputation in connection with the West African rates; and resolutions were passed pointing out to the Government the necessity of inserting State-purchase clauses in all future cable contracts, and the importance of prohibiting pooling arrangements between the Pacific Cable Board and private companies.

Pacific Cable.—The *Times* correspondent at Ottawa says that the officials sent to the west coast of Vancouver Island have selected San Juan and the mouth of Banfield Creek as alternative points for the landing place of the Pacific cable. The places are respectively about 100 and 125 miles distant from Victoria. Mr. Peake, the engineer sent out by the Pacific Cable Commission, is head of the expedition.

Paris-Marseilles Telephones.—The engineer Mongeot is at present studying a project for the establishment of a new telephonic system which is intended to connect Marseilles with the various towns of the Mediterranean. A direct line would unite Paris with Marseilles, thus placing Paris in communication with Cannes, Mentone, &c.

Underground Telegraph Wires.—At the monthly meeting of the Council of the Bradford Chamber of Commerce on 27th ult. it was stated that some time ago the Chamber, in conjunction with the Glasgow Chamber, urged on the postal authorities the extension northwards from Birmingham of the underground trunk telegraph system which has recently been constructed between London and that city. The Postmaster-General now wrote in reply stating that the new system had proved a great advantage during the storms which occurred last year, although it was subject to some drawbacks, as two wires were required to form a circuit where one overhead formerly sufficed. On the whole, however, the Postmaster-General felt justified in extending the system further northwards, and sanction for the necessary expenditure would be sought. He further hoped to also lay an underground section from Preston northwards, where the existing overhead wires were much exposed to storms.

Wireless Telegraphy.—At the last meeting of the Cape Town Chamber of Commerce, the Management Committee reported that in accordance with the wishes of the Chamber they had waited on the Acting Postmaster-General and urged the desirability of connecting Dassen Island with Signal Hill (Cape Town) by the Marconi system of telegraphy. In reply to the Committee's representations, Mr. Duff stated that in the opinion of the department the time had not yet come for the introduction of Marconi telegraphy for commercial purposes, but expressed the hope that the day was not far distant when the mode of telegraphy would be so far perfected as to enable it to compete favourably with the cable system for such short distances as between Cape Town and Dassen Island.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aylesbury.—April 22nd. The U.D.C. wants tenders for establishing and maintaining electricity works. See "Official Notices" March 22nd.

Barrow-in-Furness.—April 24th. The Corporation wants tenders for concentric cables, boxes, cast-iron pipes, conduits and pipes, balancing transformer and switchboards. See "Official Notices" to-day.

Battersea.—April 30th. The Council wants tenders for electric pumps and pipe work, river work, pipe and pits, &c. See "Official Notices" March 29th.

Burnley.—April 9th. The Electricity Committee wants tenders for boilers, economisers and accumulators. See "Official Notices" March 29th.

Colwyn Bay.—April 13th.—The U. D. C. wants tenders for water-tube boiler, feed pump, injector, piping, &c. See "Official Notices" March 29th.

Dublin.—April 22nd. The Lighting Committee wants tenders for condensing plant, pipework, feed pump, superheaters, mechanical coaling apparatus, crane, and workshop equipment. See "Official Notices" March 22nd.

Edinburgh.—April 20th. Tenders are wanted by the Corporation for arc lamp carbons and cast-iron pipes. See "Official Notices" March 29th.

Egypt.—April 15th. The Ministry of Public Works, Cario, will on April 15th consider tenders for the installation of electric light in the town of Zagazig.

France.—April 18th. Tenders are being invited until April 18th by the French Ministry of Posts and Telegraphs, for the supply of 270 tons of copper or bronze wire. Tenders to be sent to Le Sous-Secretarial d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Halifax. — April 11th. The Electricity Committee wants tenders for steam piping and trolley wire. See "Official Notices" March 29th.

Hornsey.—April 11th. The U.D.C. wants tenders for dryback boilers, pumps, economiser, 300-KW. steam dynamos, motor

transformers, condensing and water cooling apparatus, pipework, switchboard, battery, crane, mains, arc lighting, meters and workshop equipment, &c. See "Official Notices" March 15th.

Kirkcaldy.—April 15th. The Corporation wants tenders for two 80-I.H.P. and three 250-I.H.P. engines and continuous current dynamos, storage battery, and 15-ton crane. See "Official Notices" March 15th.

Launceston (Tasmania).—April 22nd. The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

Leeds.—April 15th. The City Council wants tenders for steam and other piping, pumps, economisers, &c., all for engines of 4,000 I.H.P. See "Official Notices" March 15th.

London.—April 24th. The Metropolitan Asylums Board invites tenders for gas producing plant and gas engines, dynamos, accumulators, and switchboard; Galloway boilers, economiser, feed pumps, &c., for Tooting Bec Asylum. See "Official Notices" March 22nd.

London.—The Metropolitan Electric Supply Company announce that they are considering the expediency of adopting larger units, and are prepared to receive designs, accompanied by full specification and approximate price (erected at their works in London) for complete two-phase steam units having an output of from 3,000 to 4,000 KW. at a pressure of 500 volts per phase, and at a periodicity of 60 complete cycles per second, such units to work in parallel with the existing 1,500-KW. units of the company. As an alternative, similar units generating at 10,000 volts may be considered. See "Official Notices" March 22nd.

Madrid.—April 21st. The Secretary of State for Foreign Affairs has received a despatch from his Majesty's Ambassador in Madrid, stating that tenders are invited by the Spanish Government, not later than April 21st, for the establishment and working of a telephone system in Palencia. Particulars may be examined at the Commercial Department of the Foreign Office, between 11 a.m and 5 p.m.

Manchester.—April 8th. The Lancashire and Yorkshire Railway Company wants tenders for 12 months' supply of stores, including telegraph and electric light accessories. See "Official Notices" March 29th.

Middlesbrough.—April 30th. The E.L. Committee wants tenders for a Lancashire boiler, 300-KW. steam dynamo, condensing plant, and piping. See "Official Notices" March 29th.

We would draw tenderers' special attention to the latest date for sending in estimates. It is April 30th and not 13th, as appeared in our "Official Notices" last week.

Motherwell.—April 29th. The T.C. wants tenders for steam dynamo and switches and piping. See "Official Notices" March 29th.

Partick.—April 9th. The Council wants tenders for steam and other pipes, pump, tank, feed water heater, and ironwork, &c. See "Official Notices" March 22nd.

Piatra Neamtz, Roumania.—April 23rd (new style). The mayor will on this date consider offers for the concession of supplying the town with electric light for a term of 30 years.

Poplar.—May 1st. The Guardians want tenders for steam, exhaust, and other piping, valves, &c. See "Official Notices" to-day.

Portsmouth.—April 16th. The Corporation wants tenders for boilers, pumps, stokers, economisers, pipes, &c. See "Official Notices" March 29th.

Roumania.—April 9th. The Roumanian Ministry of of Posts and Telegraphs in Bucharest is inviting tenders until the 9th inst., for the supply of 20 tons of galvanised steel wire 2 mm. diameter.

Roumania.—April 10th. Tenders are being invited until April 10th by the municipal authorities of Piatra Neamtz for the concession for the electric lighting of the town during a period of 30 years.

Salford.—April 9th. The Corporation wants tenders for wiring for motors, dynamo leads, engine room and switchboard connections, &c., at the Strawberry Road generating station. See "Official Notices" March 22nd.

Southwark.—April 19th. The Council wants tenders for incandescent lamp brackets, switches and fittings, for gas standards. See "Official Notices" to-day.

Spain.—April 22nd. The Spanish Ministry of Posts and Telegraphs in Madrid is inviting tenders until April 22nd for the concession for the establishment and working during a period of 20 years of a telephone exchange in the town of Palencia. Particulars may be obtained from, and tenders are to be sent to, the Registro de la Direcion General de Correos y Telegrafos, Madrid.

CLOSED.

Llanrwst.—The Hart Accumulator Company has recently secured the contract for the supply of a storage battery required for the electric lighting of Llanrwst, Wales.

Bombay.—The Municipal Commissioner has sanctioned the purchase from Messrs. John Fleming & Co. of 3,700 cored carbons and 3,700 solid carbons, required for the arc lamps at the Crawford Markets, at a rate of Rs. 70 per 1,000 ft.

Derby.—The E.L. Committee has accepted the following tenders:—Messrs. E. Green & Son, for fuel economiser, £575; Messrs. Babcock & Wilcox, for boiler and purifier £1,030, and steel piping, valves, feed pumps, &c., £600.

Dublin.—On Monday last week, after a prolonged discussion, the City Council passed the report of the Lighting Committee, and accepted the tender of Messrs. J. & W. Stewart, of Belfast, at £29,051 9s. 3d. for building the electricity works and chimney shaft at Pigeon House Fort.

Haslingden.—The Town Council received tenders for the construction of a three-cell refuse destructor and Lancashire boiler from the Horsfall Destructor Company and Messrs. Meldrum Bros., and that of the latter firm was accepted. The destructor is to be combined with an electric lighting station.

Hornsey.—At Monday's meeting of the District Council, the Electricity Committee recommended the acceptance of the tender of the Alphons Custodis Chimney Construction Company of Sheffield, for the erection of a shaft at the new electric lighting station at a cost of £2,300, the same to be 180 ft. high. The lowest tender of the 13 for a brick shaft was £3,500. After discussion, an amendment was defeated, and the Council adopted the recommendation.

Leeds.—At the City Council meeting on Wednesday, the Lighting Committee advised the acceptance of tenders for works required in the construction of a subway for electric cables in Whitehall Road, Northern Street, Wellington Street, and Queen Street, as follows:—Mr. Paul Rhodes for excavators, masons, bricklayers, concreters, and carpenters' work, £9,697; Mr. Leonard Cooper for smiths and ironfounders' work, £2,076.

FORTHCOMING EVENTS.

Wednesday, April 10th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, 207, Bath Street.

Friday, April 12th.—At 8 p.m. The Institution of Junior Engineers. Meeting at the Westminster Palace Hotel. Paper on "Iron-lined Tunnelling Construction" by Mr. A. Woodroffe Manton.

Saturday, April 13th.—At 3.30 p.m. The Institution of Junior Engineers. Visit the Great Northern and City Railway Works, to inspect the plant described in Mr. Manton's paper.

Thursday, April 18th.—At 8 p.m. Institution of Electrical Engineers. Meeting at Institution of Civil Engineers. At 8 p.m. Röntgen Society. Ordinary General Meeting, at 20, Hanover Square.

J. GIBBS & CO. v. CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED.

Mr. Justice Bigham, sitting in the King's Bench Division on Monday, heard this case, in which the plaintiffs, whose registered address was Chemical Manure Works, Cattledown, Plymouth, claimed £487, balance of price of goods sold and delivered to the defendants, who were manufacturers and sellers of batteries for the storage of electricity. The defendants stated that owing to some of the sulphuric acid supplied by the plaintiffs being of greater strength than that contracted for, and to the fact that certain carboys contained hydrochloric acid, damage was done to the batteries, and on this account defendants counterclaimed for £579 9s. 5d.

Mr. Bousfield, K.C., appeared for the plaintiffs, and Mr. T. Terrell, K.C., for the defendants.

Mr. Terrell, opening the defendants' case, said they had from the year 1896 and onwards been having sulphuric acid from the plaintiffs for the whole of their works all over the country, and they contracted for delivery of acid which was not to be higher or lower than 1·250 specific gravity, and which was to be pure brimstone acid. The plaintiffs knew perfectly well that the acid was used for storage batteries, and that it must be of that exact strength. On December 13th, 1899, the defendants had a very large order for storage batteries for Prince Hatzfeldt, at Draycott Park, and ordered 86 carboys of acid to be delivered to Edmundson's Electricity Corporation, Draycott Park, who were the people who were putting in the installation. The plaintiffs delivered 86 carboys of acid, which contained ·2 per cent. of hydrochloric acid, and this ·2 per cent. of hydrochloric acid beyond all shadow of doubt, as analysis had shown, had got there by common salt having been put into the acid. On analysis the exact quantity of sulphate of soda was found which would correspond with common salt having been put in. These carboys were poured into the storage batteries, and

the result was their immediate destruction. Everything had to be taken out, and put into the melting pot. The damage resulting from that was £723 5s. 4d. They were also putting in at Aberystwith some storage batteries, and directed the plaintiffs to deliver on November 13th, 1899, 36 carboys of acid of the specific gravity of 1·215. By some carelessness or other they sent acid of specific gravity of 1·750, the strength used for manure. Two of the carboys were poured into the battery, and the result was the destruction of two cells, the damage amounting to £24. With regard to this, the mistake was made by the railway company, and the plaintiffs were putting in a claim against the railway company. There was one claim for 30 carboys ordered on October 25th, 1899, to be delivered to Messrs. Crompton, Castle Hill, Redhill, Surrey. The acid was of the specific gravity of 1·740 instead of 1·250. The plaintiffs had paid £9 into Court on that claim, and £65 generally.

In answer to a question from his Lordship,

Mr. Bousfield said with regard to the item of £24, he could show that the plaintiffs had delivered two consignments to the railway company, who had mixed them. With regard to the larger claim, he denied that there was any hydrochloric acid contained in the acid supplied, and further said that if there was, it could not do the slightest harm. In this case the acid was left for months, and it was the defendants' own fault if any harm was done.

Evidence was given by Mr. Grindle, manager of the defendant company, who said the presence of hydrochloric acid was fatal, and the effect was immediately apparent on the plates. They were not of the slightest use, and had to be "scrapped."

In cross-examination, he said that the plates were tested in February and March, after they had been rejected, but that was only for the sake of information. The effect of the presence of hydrochloric acid was that it attacked the peroxide of lead on the positive plates, which were gradually disintegrated. The disintegration would make itself obvious by smell and by clouds of chlorine being given off. In the course of manufacture chloride pellets were used to obtain porosity, and it was of vital importance that the chloride should be extracted from the lead before use. If it was not extracted, however, the use of sulphuric acid would not cause chlorine to be given off in fumes.

Mr. Bousfield: Taking a new pair of your plates, and putting them into pure acid, they gave off fumes of chlorine. Can you explain that?

The Witness said he could not explain it, and he doubted it. He had never come across a case of the defendants' plates containing chlorine. The batteries were left at Draycott Park for what they were worth, and supplied the light for some months.

Mr. J. Swinburne, consulting engineer, said he had analysed the sulphuric acid, and found 2½ in 1,000 of hydrochloric acid. He was of opinion that it would be hopeless to save a battery into which this impure acid had been poured.

Mr. Horatio Ballantyne gave similar evidence with regard to analysis.

Replying to a question from his Lordship, Mr. Bousfield said the plaintiffs had tested the acid in the carboys and found hydrochloric acid, but they could not tell whether the acid had not been poured back into the carboys from the batteries.

The Witness said that could not have been, because there was no lead present in the acid.

At the close of the defendants' case on their counterclaim, Mr. Bousfield said he would not address his Lordship at this stage, but would simply call his witnesses, and accordingly

Dr. Messel, examined by Mr. Bousfield, said he was a member of the Council of the Chemical Society, vice-chairman of the Society of Chemical Industry, and a member of the Chamber of Commerce. Witness said he was a partner in the firm of Messrs. Spencer, Chapman & Co., who were responsible for the manufacture of the sulphuric acid supplied to the plaintiffs. The firm took every precaution to free the stuff from arsenic. The firm supplied the plaintiffs with the 86 carboys of sulphuric acid. He knew it was suggested that the acid as used contained hydrochloric acid and sulphate of soda. In their works there was no possibility of salt getting into the stuff.

Cross-examined by Mr. Terrell: Their order was to supply sulphuric acid at a certain strength. His firm were responsible for the acid supplied to the plaintiffs. He was not aware that the plaintiffs had made a claim against his firm in respect of the sulphuric acid. His firm were the largest makers of sulphuric acid in London. He did not think it was possible in their works for the hydrochloric acid to have got mixed with the stuff.

Mr. P. Quin, examined by Mr. Bousfield, said he was foreman of Spencer, Chapman & Co., and it was his duty to see to the manufacture of the acid. It was reduced to strength 1·215 by water. For that they used a closed tank. He did not see any way by which 30 lbs. of salt could have got into the stuff. If it got in, it must have got in outside the process of manufacture. He could not see how hydrochloric acid could have got into the stuff in the process of manufacture.

Henry Overpage examined, said he was sampler to Messrs. Spencer, Chapman & Co. He dealt with the sulphuric acid, and reduced it to the dilute state. He did not think it possible for a carboy for which hydrochloric acid had been used to be used for sulphuric acid. The carboys used for both stuffs were properly labelled.

Mr. Wood examined, said he was in charge of the batteries at Prince Hatzfeldt's. It was his duty to run the battery and keep it clean, and to look at the plates from time to time. He did not see any difference between the first battery, second battery, and the last battery. The first battery lit the house properly.

Cross-examined: He was not an expert electrician.

In giving judgment, his Lordship said that the conclusion he had arrived at was that the damage done to the batteries was not due to the acid supplied by the plaintiffs, whatever other cause it might be attributable to. The defendants had failed to discharge the onus which devolved upon them of satisfying him that the damage was caused as they alleged. The plaintiffs, however, in his opinion, had been guilty of a breach of contract. They had not delivered the acid which they undertook to deliver. They undertook to deliver an acid with no admixture of hydrochloric acid, and he thought the defendants had not been unreasonable in setting up their counterclaim. The conclusion he had come to was that the plaintiffs must bear part of the blame, and, therefore, he proposed to deprive them of their costs on the counterclaim. There would, therefore, be judgment for the plaintiffs on the claim, and for the plaintiffs on the counterclaim, without costs.

We understand that the case will go to appeal.

NOTES.

Street Lighting in Cities.—The New York *Electrical World* recently abstracted a paper read by Mr. H. H. Humphrey before the Engineers' Club of St. Louis, in which he described the plant of the Imperial Electric Light, Heat and Power Company, which plant also furnished the subject of a paper read by Mr. George A. Damon in 1898 before the American Institute of Electrical Engineers. Several paragraphs of the paper gave an account of trouble with the underground distribution from static discharges. It was believed that drawing both cables through a single iron duct leading to the base of the iron arc lamp poles used, would provide a sufficient connection between the two so that the lead sheaths would be practically connected together throughout the entire circuit. At the plant all of the six cables of the three circuits installed were also drawn into a single duct of the conduit with the same object in view. It was ascertained, however, soon after starting the plant, that these contacts were not sufficient. A static effect from the cables manifested itself in the short-circuiting of arc lamps through the insulation at the top of the enclosing globe where the full difference of the potential of the lamp is maintained. The lead sheaths of all the cables were then securely soldered together in the manholes where they enter the duct which goes to the lamp poles, and they are also connected together at the station just behind the switchboard. This, however, had little if any beneficial effect upon the portion of the circuit. A special static discharger was then installed, consisting of an ordinary Leyden jar condenser connected to the copper of each circuit at the rear of the station switchboard. Each condenser is provided with a revolving contact arm driven by a small motor, which alternately connects the condenser to positive wire, to ground, to negative wire and to ground, thus receiving a charge from the line and discharging it to ground about 30 times per minute. After this apparatus was installed the static effect of the cables was unappreciable in the operation of the plant. A test of the motor-driven arc-lighting units of the Imperial plant showed that the average efficiency of a unit was 80·5 per cent., reaching in one case as high as 82·5 per cent. and another 82·4 per cent.; the guaranteed efficiency was 78·25 per cent. At present the Imperial station has a maximum load of about 13,000 amperes, and an average load of 6,345 amperes. During the past year the load factor of the plant has increased from 39·27 to 47·7 per cent. A switch was described whereby a number of incandescent street lighting circuits are switched in and out by means of current from the arc-lighting circuits. When the arc current is turned on it operates a solenoid which closes a switch controlling the incandescent street-lighting circuits. In the morning, when the arc circuit is shut down, the plunger of the solenoid is released, thereby opening a switch and cutting the incandescent lights out of circuit.

"Ark" Lamps.—Messrs. Johnson & Phillips have just received an order for a considerable number of these lamps for the lighting of the Boer prisoners' camps at Ceylon. The essence of the order was quick delivery, and this they were able to comply with as they are now turning the lamps out at the rate of 100 to 200 per week.

(*Continued on page* 593.)

THE CONSTRUCTION OF AN ELECTRIC TRAMWAY MOTOR.

By S. H. SHORT.

(*Concluded from page* 547.)

The Armature.

The armature or revolving magnet, which is of the iron-clad type, weighs, complete, 484 lbs. The core or body of the armature is built up of discs punched from squares of thin sheet steel of special quality, the material having very high magnetic conductivity and very low hysteresis loss. These discs come from the dies (fig. 8) with 41 slots in their edges, a hole in the centre to admit of their being strung on the armature shaft, and five openings arranged symmetrically around the centre to admit air into the interior of the armature core for ventilation.

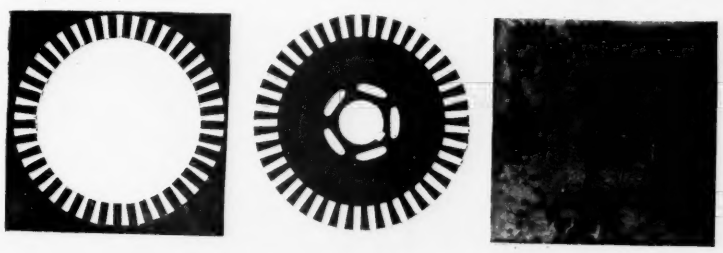


Fig. 8.—Core Disc and Blank.

Fig. 9.—Steel Shaft, Rough and Finished.

The shaft upon which the discs are securely keyed is (fig. 9) a bar of the best hammered steel, 3 in. in diameter, carefully turned, accurate to $\frac{1}{1000}$th part of an inch. The portions which revolve in the bearings are ground to perfect cylinders in a special grinding machine with micrometer adjustments. One end is tapered to receive the compressed steel pinion, which is secured in its place with a steel nut and lock washer. A key-way is cut the full length of the shaft, between the bearing surfaces, to receive a spline which secures the armature core and commutator.

On to this shaft is forced a cast-iron head, provided with a curved flange at its periphery to receive and protect the ends of the armature coils (fig. 10). The slotted discs are next threaded on to the shaft, with $\frac{1}{2}$-in. ventilation spaces at intervals made by inserting special spacing discs. When a thickness of $7\frac{1}{2}$ in. has been attained, another iron washer is put on and firmly fastened by a steel nut and lock washer, clamping the whole tightly together into a complete armature core with the slots on the periphery running parallel with the shaft. (Second view, fig. 10.)

The Commutator.

We will next take up the construction of the commutator, as this most important and troublesome part of the apparatus must be placed on the armature shaft before we can proceed further with the building of our machine.

The commutator is to the motor what the valve gear is to the steam engine, for it directs the flow of electricity into the armature coils in such a way as to produce the proper rotatory motion.

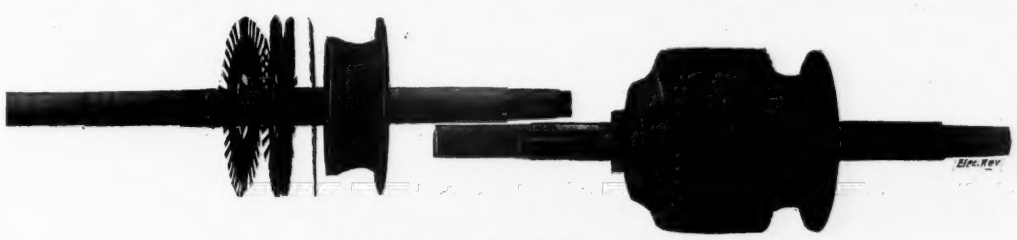


Fig. 10.—Building-up the Armature Core.

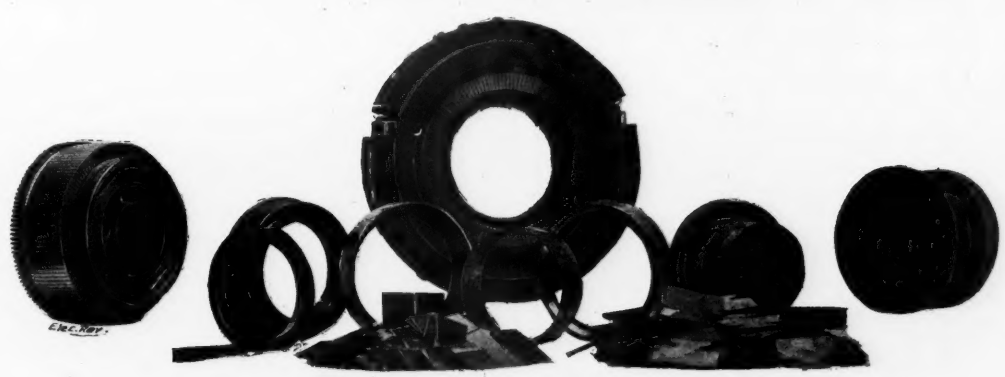


Fig. 11.—Component Parts of Commutator.

The commutator and its various parts may be seen in the illustration (fig. 11). It is 11 in. in diameter, contains 123 hard drawn copper bars 4 in. long, has a wearing face of 3 in. where the carbon brushes run, and a maximum wearing depth

of 1 in. We wish to call special attention to these ample dimensions, and the low pressure secured between individual segments without reducing the width of the bars at the commutator face. The commutator, therefore, runs cool, without sparking, and will wear much longer than the smaller ones generally used.

The commutator is mounted on a cast-iron hub accurately bored to fit the armature shaft, and provided with two inwardly projecting V-shaped flanges carefully finished to a standard jig. Micanite insulating rings moulded under high pressure fit these V-shaped flanges, no joints or openings being left to tempt leakage of the electric current.

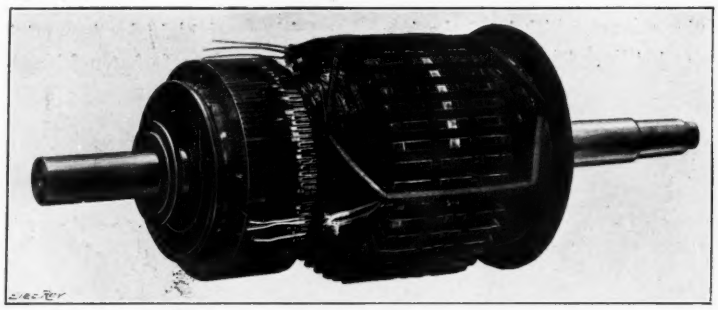


Fig. 12.—Armature Body, with one Coil in Place.

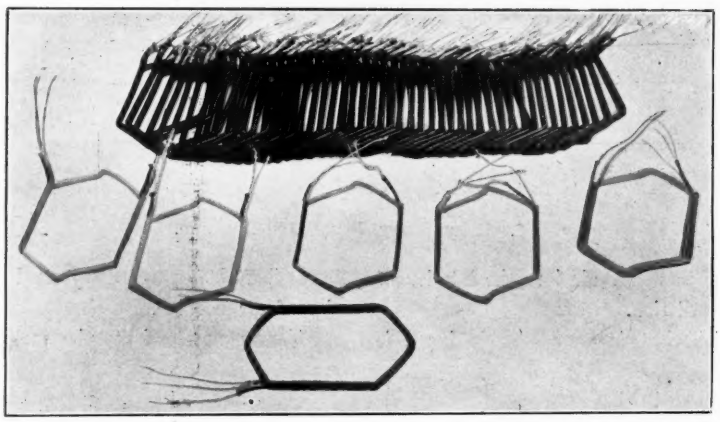


Fig. 13.—Details of Armature Coils.

Between these flanges is clamped the hollow cylinder made of alternate bars of copper and thin strips of silver amber mica. The copper commutator bars and mica plates are first assembled in ring form and held tightly in a clasp, while the ends are turned true and grooved to receive the V-shaped flanges of the commutator hub. Before being assembled the bars have a narrow slot sawn in one end to receive the terminals of the coils of wire which are placed in the slots on the armature core.

Openings are formed in the commutator hub so that its interior and the space between it and the armature core will be traversed by currents of cool air.

The insulation of the finished commutator is tested with 2,000 volts alternate current between the segments and the hub, and with 500 volts between adjacent bars, after which it is secured in its place on the armature shaft by a special nut and lock washer.

The armature body (fig. 12) is now ready to receive the coils or windings through which the electric current passes from the commutator, and the photograph shows one of these coils being placed in the slots.

Armature Coils.

Again we must stop to describe another process of the most vital importance, *i.e.*, the winding and insulating of the armature coils.

These coils are made from 100 per cent. conductivity copper wire covered with a triple layer of the best cotton thread. The wire is wound by machinery into a rectangular form with V-shaped ends, thus making the coils all alike and interchangeable. After being wound they are put into a drying oven in which the temperature is kept at 250° F., driving all of the moisture from the cotton. They are then dipped into a special insulating compound and re-dried. This operation is repeated several times, until the coils are thoroughly covered with a tough flexible material, which will withstand the very highest insulation tests.

Three of these coils are laid together and incased in a box or trough made from mica, pressboard and linen, after which the compound coil is taped throughout its entire length with two layers of thin webbing. The triple coil thus formed is given its last treatment by being dipped in armature varnish and again baked.

The terminals, which all come out at the same end of the coil, are indicated by braided coverings, one being red, the next white, and the third blue, in order that no mistake may be made when connecting them to the commutator bars. There are 41 triple coils for each armature, and six terminals to each coil, thus providing two wires to connect with each of the 123 bars of the commutator.

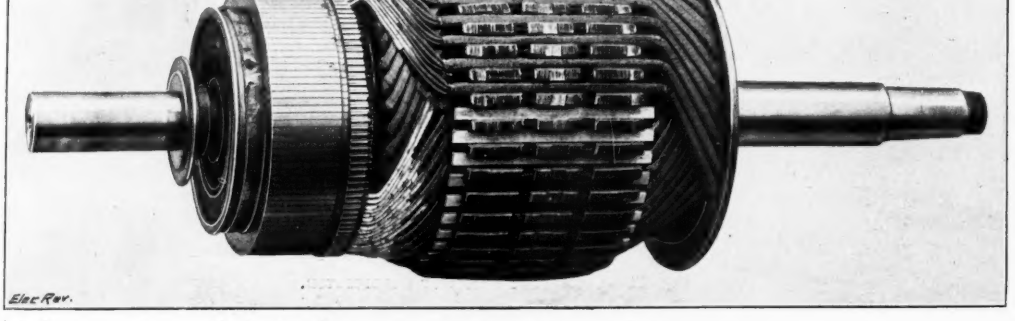


Fig. 14.—Armature Partly Wound.

The whole process of manufacture and insulation of these coils of wire may be followed by referring to fig. 13. The photograph shows the three coils laid together before insulating and taping, and coils in various other stages of construction; also one coil entirely completed, together with a

set of 41 coils fitted together in the relation which they will have to each other when on the armature core.

Winding.

The slots of the armature core are carefully filed smooth and clean before the coils are placed in them, so that there will be no rough edges or corners to cut through the insulation.

counteract the centrifugal force which would otherwise throw the coils out of the slots when the armature is revolving at a high rate of speed.

The windings are protected on the periphery of the armature by the teeth projecting beyond the coils, the retaining bands being let into grooves on the surface of the core. The flange of the end plate of the core forms a most perfect protection to the end winding both from mechanical injury and from oil.

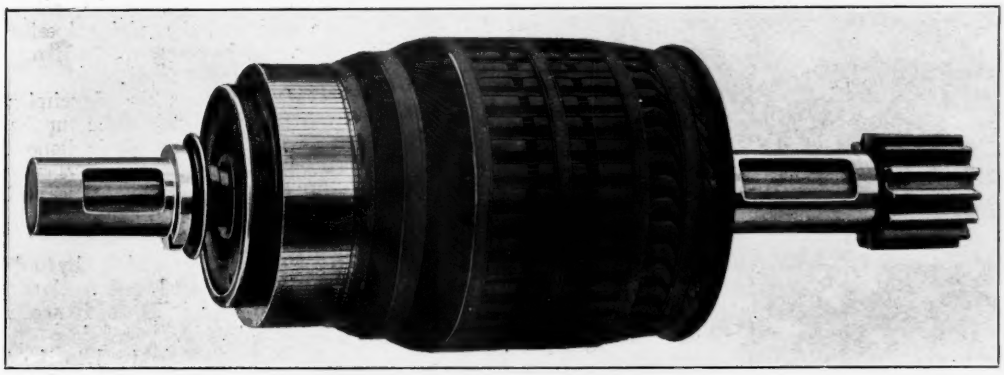


Fig. 15.—Complete Armature, with Pinion.

The winding consists of placing 41 rectangular coils into the 41 slots on the periphery of the armature core; this must be done with the greatest care in order that the insulation on the coils may not be injured. One side of each coil is placed in the bottom of the slots all the way round the armature, with the terminals towards the commutator. The other sides of the coils, which reach over to span 10 teeth, are then placed in the upper portion of the slots. The terminals of the coils are connected with the ends of the commutator bars to which they belong, and carefully soldered to make a good electrical connection.

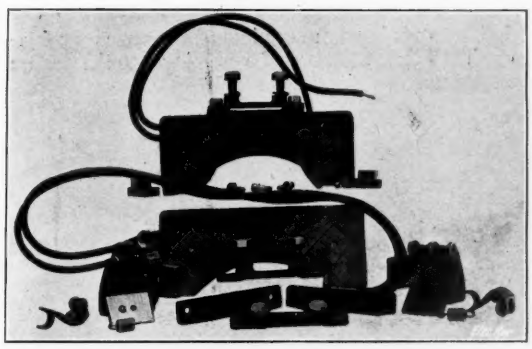


Fig. 16.—Details of Brush Gear.

We reproduce a photograph of an armature core (fig. 14) with a little over one-quarter of the coils in place, showing very clearly the method of winding. If one of these coils should be injured, it may be removed and replaced with a new one by raising the upper sides of one-quarter of the coils.

There only remains for the completion of the armature the placing at intervals around its face and over the end windings of narrow bands of a special tinned steel wire, one strand of which will sustain a 500 lb. weight. These bands are secured by clips thoroughly soldered together, and

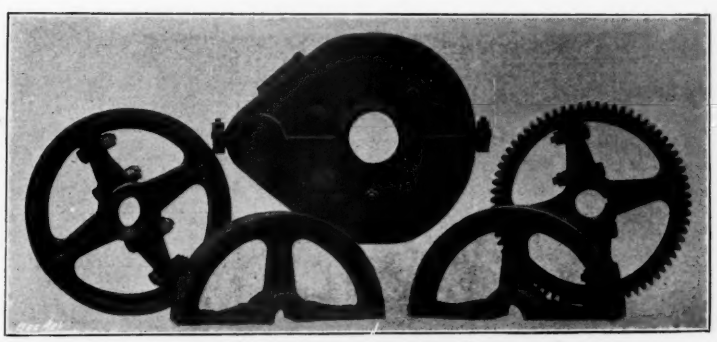


Fig. 18.—Axle Gear and Housing.

These armatures can, therefore, be rolled about the floor of the depôts without fear of injury.

Fig. 15 shows the complete armature ready to be placed in the motor, and its hammered steel pinion, which has 14 teeth and a face of $4\frac{3}{8}$ in.

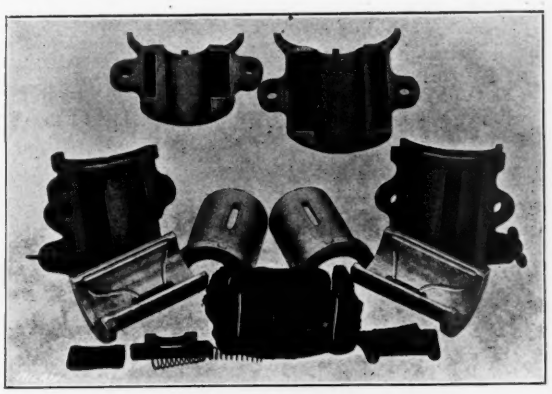


Fig. 17.—Details of Bearings, &c.

The electric current reaches the armature windings through carbon brushes held in position against the commutator by means of bronze brush holders. Each holder contains two brushes fitted with independent spring fingers. These holders are supported on a hard wood yoke, which is bolted to the upper casting of the motor frame. The brushes are placed at an angle of 45° on either side of the vertical plane, on the upper half of the commutator; they are therefore, immediately under the opening in the motor shell, and can be reached without difficulty by swinging back the commutator cover. The brushes are adjustable lengthwise of the commutator so that they may be made to run in the proper position on its face, while radial adjustment is provided to follow the wear of the bars.

Fig. 16 is a photograph of the yoke with its two brush holders, the bolts for securing it to the motor frame, the various parts which make up the brush gear, and the two cables attached to the brush holders. These cables pass out through an opening in the upper half of the motor frame, ready for connection with the car wiring.

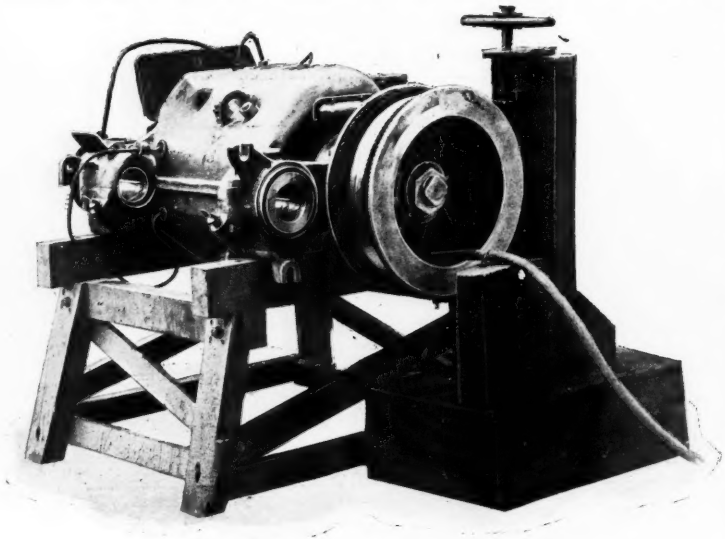


Fig. 19.—Efficiency Test of Motor.

Bearings and Lubrication.

It is very important in designing tramcar motors to properly proportion the bearings, and to provide them with most perfect lubrication in order that they may run several days without attention. The materials used for these bearings are also of the greatest importance. The armature bearings in this motor are made of bronze, while the axle bearings are malleable iron shells lined with the best white metal.

Fig. 17 illustrates the armature and axle bearing caps which secure the journals in their proper position; each cap or cover is provided with a well holding a pint or more of oil. This oil is fed through wool wicks held against the shafts by springs, the excess oil returning to the wells. Under ordinary circumstances the oil lubrication is sufficient and is found to be quite perfect, but should the oil fail, emergency lubricators are provided for the bearings in the form of grease boxes placed above them. If any heating occurs in the bearings, the thick grease contained in these boxes will melt, and flow down upon the shaft, providing it with the necessary lubricant.

Gears.

The power from the armature shaft is transmitted to the axle and car wheels through spur gears. The loss in this transmission must be small; it is therefore important that the gear and pinion should be fitted as perfectly as possible, and materials used in their construction which will not wear rapidly. The pinion is made of hammered machine steel with the teeth cut from the solid metal.

The accompanying illustration (fig. 18) shows the axle gear in its various stages of manufacture. It is cast in halves from a special grade of steel which has great strength and wearing qualities. The castings are machined and bolted together, after which the centre is bored to the diameter of the car axle and the outer rim is faced and trued on its sides. The teeth are then cut from the solid metal in the periphery of the wheel. The gear halves are held together with eight bolts, and can be applied to the car axle without disturbing the wheels. The pinion and gear run in oil contained in a malleable iron oil-tight gear housing, which is supported by the axle bearing at one end, and the pinion bearing at the other, and is securely bolted to the upper half of the motor frame.

This completes the description of the various parts which make up the tramcar motor. They are made in large quantities to special patterns and jigs, all alike and interchangeable, and are delivered to the assembling department, where the motors are put together.

When complete and ready to be tested, the motor weighs 1,934 lbs. For a thorough test the motor is mounted upon a suitable platform (fig. 19).

A Prony brake is fitted to the armature shaft, and the motor run under full load for one hour; the temperature is then measured by a thermometer and the performance of the bearings and commutator is noted. At the end of the run, while the motor is still warm, its insulation is tested with a pressure of 2,500 volts alternating current.

The efficiency and speed of the motor at various loads are carefully measured from time to time, to see that no great variation occurs between machines of the same capacity, and to catch any defect that may be creeping into the process of manufacture.

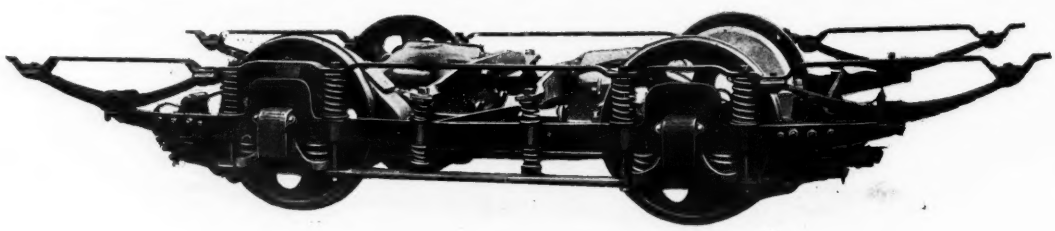
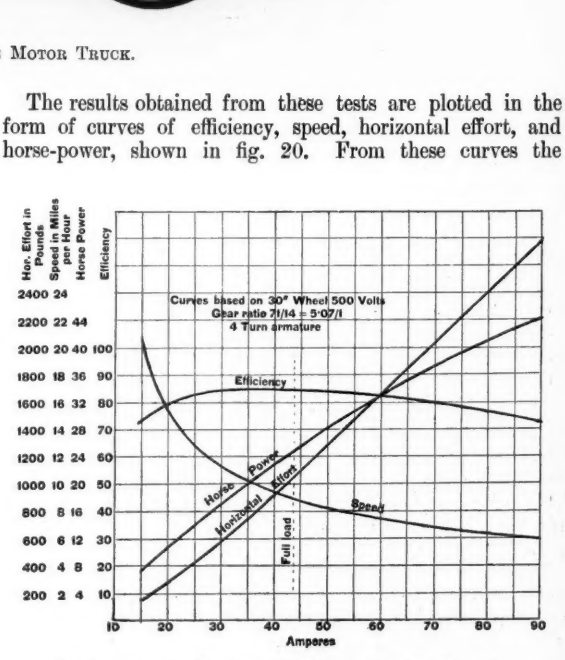


Fig. 21.—Complete Motor Truck.

The results obtained from these tests are plotted in the form of curves of efficiency, speed, horizontal effort, and horse-power, shown in fig. 20. From these curves the performance of the motor can be determined for any service to which it is intended to be applied.



Characteristic Curves of Motor No. 25, Type A.

The motors are usually mounted in a single truck, one for each axle (fig. 21).

All the wheels are therefore drivers, enabling the tramcar to accelerate rapidly even with the track in the slippery condition usual in city streets.

Standard motors are being manufactured in sizes varying from 25 H.P. for the smaller, to 150 H.P. for the larger ones. The smaller machines are used for city service, while the large ones, with capacities of from 100 to 150 H.P., are used to drive trains of cars on suburban and interurban lines.

NOTES.

(*Continued from page* 588.)

Personal.—A pleasing ceremony was performed last Friday afternoon at the Dickinson Street Electric Works, Manchester, when the members of the official staff and workmen in connection with the electricity department met together for the purpose of presenting to Mr. C. H. Wordingham, M.Inst.C.E., an illuminated address, accompanied by a valuable microscope with its accessories complete, manufactured by Messrs. Becks, of London, as a token of their high appreciation and esteem, and in recognition of the eminent services which he has rendered to the department. The address, to which were appended the signatures of the whole of the staff and workmen, read as follows:—

We, the staff and workmen of the electricity department, desire to avail ourselves of the opportunity afforded by your retirement from the important and responsible position of city electrical engineer to the Corporation of Manchester by venturing to ask your kind acceptance of this address, accompanied by a microscope, as a small token of our high appreciation and esteem, and in recognition of the eminent services which you have rendered. We have not failed to recognise the straightforward and honourable principles which have actuated you in all your business relations during your period of office here, and we desire to place on record the extreme courtesy and friendly feeling which you have always manifested. We much regret that you are leaving, and in asking your acceptance of this address, we beg to convey to you our heartfelt wishes for your future welfare, and sincerely trust that you will be spared to enjoy a long, happy and prosperous life.

The illuminated address and microscope were presented in a very able manner by Mr. W. F. Long, the senior assistant engineer remaining at the works. Mr. Wordingham heartily thanked those present for the handsome gift presented to him. In an appropriate speech he stated that he was particularly pleased with the unanimous expression of goodwill, and, although he fully valued the magnificent instrument, he appreciated the illuminated address in a much fuller sense, as he knew that the signatures contained therein were the names of sincere friends. Mr. Wordingham was listened to with every attention, and at the close hearty cheers were given for one whose best years had been given in the service of the Department, and whose efforts had been the means of making the undertaking, not only a successful one financially, but also one the magnitude of which was equalled by only a few in the United Kingdom.

At the South Shields Corporation electricity works on Saturday last, Mr. W. S. Toplis, mains superintendent, who is leaving South Shields to take up a more important appointment at Manchester, was the recipient of a handsome black marble timepiece as a mark of esteem and respect from the staff, workmen and contractors connected with the above works. Mr. Jeckell, borough electrical engineer, made the presentation.

Mr. Wm. R. Potter has resigned his post as district manager of the National Electric Wiring Company in the Crewe and Alderley Edge districts, having been appointed manager and engineer of the free wiring department of the Newcastle-on-Tyne Electric Supply Company, in connection with the large extension schemes which the company have in hand.

Mr. W. T. Golledge, A.I.E.E., who has for the past 4½ years acted as resident electrical engineer at the Royal Agricultural Hall, representing Messrs. F. A. Glover & Co., of 97, Queen Victoria Street, E.C., was presented on Friday last by the staff of the firm, with a very handsome combination cabinet, suitably inscribed, on his relinquishing his appointment to take over the management of the electrical department of Messrs. Aublet, Harry & Co., Limited, of 53 and 55, Curtain Road, E.C.

Mr. A. D. James, who for the past two years has been engineer-in-charge at the Palace Theatre, relinquished that position on Saturday, March 23rd. The electrical and engine room staff presented him with a momento, which took the form of a travelling bag and a case of companion briar pipes.

Mr. T. H. Minshall, borough electrical engineer of Croydon, is at present on a visit to the United States, acquiring knowledge of large American electrical and shop installations. The New York *Electrical World* says: "While Mr. Minshall does not expect to actually place any orders for equipment during his sojourn here, it is suggested, through usually well-informed channels, that his present visit will result in the all but immediate placing of substantial contracts for American electrical machinery, &c., required for an extension of the Croydon and other British traction systems with which he is identified."

The same contemporary says that Messrs. F. Hird and R. Dumas, engineers of Siemens Bros., Limited, of London, have sailed for England. They spent a busy month in America, visiting a number of prominent manufacturing establishments. They also studied American tools, lighting stations, railway plants, &c.

Mr. George Isley, senior first-class assistant in the telegraph branch, General Post Office, Liverpool, closed his official career on Saturday last, after more than 40 years' service in connection with telegraphy.

On March 28th, Mr. John MacLeod, jun., managing director of Messrs. Pulford Bros., Limited, of Liverpool, was married to Ellen Graham, of Ballurran, Kilkul, County Down, Ireland, at the Wallasey Presbyterian Church.

Mr. A. B. Rigby has been appointed manager to the Electrical Transmission Company, of Hammersmith.

Mr. J. F. C. Snell, the electrical engineer to the Borough of Sunderland, has had a most regrettable, and at the same time, a somewhat curious accident. The other day he was golfing at Coxgreen, in the neighbourhood of Sunderland, when his opponent's ball struck him a severe blow on the head. He was rendered unconscious, for some time suffering from concussion of the brain. According to the latest information, although still confined to his house, he is improving, and only rest and quietness are required to complete his cure.

There were 57 applicants for the post of city electrical engineer and manager at Lincoln, vacated by Mr. Vesey Brown. Four were selected for interview, and Mr. Stanley Clegg, of the Darwen Electricity Works, was appointed.

American Submarine Boats.—It appears that the Americans are putting considerable faith in the submarine boat of the *Holland* type; six of these, exclusive of the *Holland* and *Plunger*, are in hand. There are the *Adder*, *Maccarin*, *Porpoise* and *Shark* being built by the firm of Lewis Nixon, at Elizabeth Port, New Jersey, while the *Grampus* and *Pike* have been given to the Union Ironworks, San Francisco. The Bureau of Construction having given much attention to the subject of submarines and some assistance to those experimenting in this line, believes that the success hitherto attained has demonstrated their practicability. These boats are driven by electricity below the surface, the main motor being of the "electric waterproof" type, developing 70 H.P. and giving a speed of seven knots. The engines which drive the boat on the surface and charge the accumulators give an I.H.P. of 160, and are Otto gasoline four-cylinder engines. These boats are 63 ft. 4 in. long and 11 ft. 9 in. in diameter; they are cigar shaped, and displace 120 tons. The gasoline tank capacity will be 850 gallons. The armament will consist of five 18-in. Whitehead torpedoes, which may be fired electrically from the conning tower. There is to be only one expulsion tube. The contract price of hull and machinery is about £35,500.

Lectures.—Before the Yorkshire Association of Engineers and Firemen, at Dewsbury, last Saturday, Mr. Wilson Hartnell lectured on "Electric Transmission of Energy."

Mr. Granville Baillie, of London, lectured before the Winchester Literary and Debating Society on "Illumination, Electrical and Other," on Monday evening.

Wireless Telephony.—Since Dr. Simon discovered that the electric arc acts as a telephone (see Electrical Review, March 25th, 1898) various improvements and new applications of his methods have been made by Duddell, Ruhmer and other investigators. Dr. Simon has himself recently made a remarkable application of his discovery to the transmission of speech to considerable distances by means of the beam of light emitted from the reflector of an ordinary searchlight. The arc of the searchlight is converted into a "speaking arc" by any of the known arrangements such as Duddell's or Ruhmer's. The variations of current produced by the influence of the telephone on the arc, naturally give rise to corresponding variations in the intensity of light emitted by the arc. The receiver is the same as that used by Graham Bell in his photophone, namely, a selenium cell placed at the focus of the parabolic reflector which receives the pulsating beam of light. A telephone in the circuit of the selenium cell translates the pulsations of the light into speech. Experiments carried out by Dr. Simon at Frankfort within the last few months, have proved that such a method of "wireless telephony" is quite practicable. It is necessary, however, that the selenium cell should be very sensitive, and that its resistance should be as low as possible. The loudness of the speech emitted was remarkable; and the variations of current were sufficiently strong to impress a record on Poulsen's telegraphone. This invention of Simon's is likely to be of great value in the Navy, since the ordinary searchlight may be used to transmit speech to any distance within its range. [*Elektrotechnische Zeitschrift*, Vol. 22, p. 196.]

Here again, no doubt, as in the case of wireless telegraphy, we see the early stages of evolution of a new and important discovery, based on experimental researches of the kind stigmatised by the so-called "practical man" as mere laboratory experiments. We hope that Dr. Simon's work will bear fruit in the near future.

Glasgow Exhibition.—In our issue of March 22nd we gave an extract from the *Glasgow Evening Times*, regarding the sizes and makers of the various plants to be installed at the forthcoming Exhibition. We are, however, informed by Messrs. Davey, Paxman & Co. that the engine which they are supplying to be coupled direct to a dynamo of the Electric Construction Company's make, is of 700 H.P., and not 375 as given in the list mentioned.

Partnership.—Messrs. Bergtheil & Young recently took Mr. Robert O. Ritchie into partnership. Mr. Ritchie had for many years acted as manager of the electrical department of Messrs. Greenwood & Batley, Limited, of Leeds. He will watch Messrs. Bergtheil & Young's business in the North, taking charge of their Manchester branch.

Royal Institution.—At this Institution last Friday the Gilbert Arc Lamp Company, Limited, exhibited their lamps and various apparatus connected therewith, more particularly their alternating current solid-carbon long-burning arc lamps. The "E.L.B." system was demonstrated by the representatives of the Electric Lighting Boards Company. All its latest improvements, including its flexible strips and many accessories, were shown.

NEW COMPANIES REGISTERED.

Electrites Company, Limited (69,580).—This company was registered on March 14th, with a capital of £500 in 1s. shares, to acquire any inventions relating to the production, treatment, storage, application, distribution and use of electricity, and in particular to acquire certain existing inventions and a registered design from F. B. Lacy, and to carry on the business of makers of electrical apparatus, and surgical, medical and hygienic appliances, &c. The first subscribers (each with one share) are:—H. E. Lacy, Red Cottage, Pinner, gent.; W. G. Bruty, 44, Lambolle Road, Hampstead, solicitor; C. K. King, Purbrook, Dorking, gent.; F. I. D. Siddall, Cheshunt, gent.; H. Wilkins, 18a, Grand Parade, Highgate, N., gent.; A. S. Duffield, Chelmsford, Essex, gent.; and L. M. Clark, 7, Belsize Square, Hampstead, N.W., gent. No initial public issue. Registered without articles of association. Registered office, Red Cottage, Pinner, Middlesex.

Manual of Electrical Undertakings, Limited (69,573).—This company was registered on March 13th, with a capital of £5,000 in £1 shares, to carry on the business of newspaper proprietors, printers, publishers, type founders, booksellers, stationers, advertising agents and contractors, &c. The first subscribers (each with one share) are:—E. Garcke, Donington House, Norfolk Street, W.C., managing director; W. L. Madgen, Surrey House, Victoria Embankment, W.C., electrical engineer; W. A. Smith, Mowbray House, Norfolk Street, W.C., manager; R. Doyle, St. Bernards, Poppleton Road, Leytonstone, Associate Institute of Secretaries; W. F. Cox, 60, Chancery Lane, W.C., solicitor; H. A. Stagg, Donington House, Norfolk Street, W.C.; and A. G. Sawell, 127, East Road, N., advertising agent. No initial public issue. The first directors are E. Garcke and W. L. Madgen. Registered office, Mowbray House, Norfolk Street, W.C.

Lahmeyer Electrical Company, Limited (69,641).—This company was registered on March 21st, with a capital of £100,000 in £10 shares, to carry on the business of electricians, electrical and mechanical engineers, contractors for the erection of electrical and other works and plant, manufacturers of and dealers in all kinds of plant, machinery, equipment, apparatus and appliances for the generation, distribution, accumulation and employment of electricity and other motive and lighting power, and any similar business. The first subscribers (each with one share) are:—A. E. Hale, 7, Ingersoll Road, Shepherd's Bush, W., clerk; P. J. Hellis, 3, Merthyr Terrace, Castelnau, Barnes, S.W., clerk; F. Merheiw, Gaywood, Onslow Gardens, Wallington, Surrey, clerk; E. W. Church, 14, Crystal Palace Road, East Dulwich, S.E., clerk; J. E. da Costa Ricci, 132, Westbourne Grove, W., clerk; H. D. Oppenheimer, 144, Sutherland Avenue, W., clerk; and R. B. Pollard, 31, Lambert Road, Brixton Hill, S.W., clerk. No initial public issue. The number of directors is not to be less than three nor more than nine; the first are to be appointed by the subscribers.

Derbyshire and Nottinghamshire Electric Power Syndicate, Limited (69,618).—This company was registered on March 19th, with a capital of £10,030, in 100 ordinary shares of £100 each and 600 deferred shares of 1s. each, to carry on throughout the whole of the counties of Nottingham and Derby (except those parts of the county of Derby which lie to the south of the River Trent and to the north-west of the boundary between the Unions of Bakewell and Chapel-en-le-Frith) and elsewhere, the business of an electric power supply company in all its branches. The first subscribers are:—A. Lupton, 6, De Grey Road, Leeds, civil engineer, with 100 deferred and two ordinary shares; M. H. Mills, Sherwood Hall, Mansfield, M.I.C.E., with 104 deferred and three ordinary shares; J. W. Thackeray, Arnobale, Nottingham, J.P., with four deferred shares and two ordinary shares; A. Grove, Berydown Court, Overton, Hants, J.P., with 100 deferred and two ordinary shares; C. Allan, Wingerwort House, Chesterfield, with four deferred and four ordinary shares; D. Fox, Calder Bank Mills, Dewsbury, manufacturer, with 108 deferred and four ordinary shares; W. W. Horsfield, Vulcan House, Dewsbury, boiler maker, with four deferred and two ordinary shares; S. J. Chadwick, Dewsbury, solicitor, with four deferred and two ordinary shares; J. Hirst, Ravensleigh, Dewsbury, woollen manufacturer, with 10 deferred and five ordinary shares; C. B. Crawshaw, Rufford Lodge, Dewsbury, colliery proprietor, with six deferred and three ordinary shares; C. Fox, Calderbank Mills, Dewsbury, manufacturer, with eight deferred and four ordinary shares; M. Deacon, Whittington House, near Chesterfield, M.I.C.E., with four deferred and two ordinary shares; R. Holliday, Ravens Knowle Hall, Huddersfield, manufacturer, with six deferred and three ordinary shares; F. Huntsman, West Relford Hall, Relford, J.P., with one ordinary share; British Westinghouse Electric and Manufacturing Company, Limited (R. C. Parsons, chairman Executive Committee), with 20 deferred and 10 ordinary shares; E. H. Fraser, Wellington House, Nottingham, J.P., with four deferred and two ordinary shares; J. T. McCraith, Park Valley, Nottingham, J.P., with four deferred and two ordinary shares; T. B. Springett, Walton Hall, Chesterfield, solicitor, with two deferred and one ordinary shares; and P. Castle-Smith, Hayes Court, Kenley, Surrey, solicitor, with eight deferred shares. The number of directors is not to be less than three nor more than eleven; the first are M. H. Mills, D. Fox, J. Hirst, E. H. Fraser, J. T. McCraith, J. W. Thackeray, C. B. Crawshaw, and A. Grove; qualification, two ordinary or 100 deferred shares. Registered by Minet, Pering, Smith & Co., 7, St. Helen's Place, E.C.

Anglo-American Aluminium Company, Limited (69,615).—This company was registered on March 19th, with a capital of £1,500 in £1 shares, to carry on the business of aluminium manufacturers, metallurgical, chemical, electrical and mechanical engineers, metal workers, machinists, fitters, galvanisers, japanners, &c. The first subscribers (each with one share) are:—P. Nelson, Stock Exchange, E.C., clerk; H. Cooke, 84, Cannon Street, E.C., publisher; C. P. Nelson, 13, Russell Road, Crouch End, N., gentleman; F. H. Blake, 25, Wilmington Square, W.C., engineer; A. Smales, Essex House, Hornsey Dane, Highgate, N., gentleman; R. E. Booker, 47, Princess Road, Kilburn, N.W., clerk; and S. F. Tottman, 125, Droop Street, Queen's Park, W., clerk. No initial public issue. Registered without articles of association.

SUPPLY STATION ACCOUNTS.

Liverpool Corporation Electricity Accounts.

The Liverpool Corporation has lost little time in issuing the electricity accounts for last year. A remarkable increase in output and revenue is shown, attributable to the important developments of the traction system. This has quadrupled the revenue from the trams supply, as will be seen by a comparison of the figures for the past three years:—

Year.	From private supply.	From public lighting.	From traction.	Manufacturing account. Sales and repairs.	Wages and material.	Profit.
1898	£50,809	£2,631	£437	£21,818	£18,954	£2,864
1899	59,713	1,925	7,362	19,501	17,432	2,069
1900	72,056	1,764	30,597	23,219	20,674	2,545

To enable the relative values of the figures per unit to be set down requires the use of three places of decimals.

General Statement.

	1899.	1900.	Increase.
Total capital expenditure ...	£769,589	**£1,048,559**	£278,970
Number of units sold	5,729,477	**11,564,335**	5,834,858
Number of lamps connected ...	237,952	**298,990**	61,038
Maximum load in KW.	5,160	**6,352**	1,192
Gross revenue	£73,504	**£109,770**	£36,266
Gross expenditure...	£33,548	**£60,292**	£26,744
Gross profit	£39,956	**£49,478**	£9,522
Average price per unit sold ...	2·89d.	**2·166d.**	−·724d.

Owing to the large traction output, the price per unit has fallen by an average of nearly ¾d. to less than 2⅛d. The output was distributed thus:—

	Units.	Prices charged.
Private supply ...	4,676,951	Lighting 4d., power and heat 2d. and 1d. per unit.
Public lighting ...	211,702	142 lamps. 2d. per unit.
Traction	6,675,682	1·1d. per unit.
Total ...	11,564,335	

Each item in the revenue account shows a reduction per unit; from all sources the receipts are now down almost to 2¼d., being ⅛d. less than in 1899.

Revenue Statement.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Increase.
Sale of energy..	£68,942	2·89d.	**£104,373**	2·166d.	−·724d.
Meter rents	1,687	·07d.	**2,029**	·042d.	−·028d.
Sale of fittings, &c.: Profits on manufacturing a/c*	2,069	·09d.	**2,545**	·053d.	−·037d.
Sundry receipts, rents, &c...	806	·03d.	**823**	·017d.	−·013d.
Gross revenue ...	£73,504	3·08d.	**£109,770**	2·278d.	−·802d.

* Manufacturing account (sales and repairs, less wages and materials).

As would be expected the costs are considerably improved by the approximate doubling of the output. The price paid per ton for coal was, however, on the average, more than 60 per cent. higher than in 1899, and this has added nearly 50 per cent. to the cost of coal per unit, which now stands at ¾d. instead of ½d. as in the previous year. Works costs suffer slightly from this change, but the reductions in other items wipe out the increase, leaving total cost at 1¼d., instead of 1⅜d. How such figures will compare with those yet to be realised by the "power companies," it would be hazardous to guess, but some very marked economies will have to be effected over the Liverpool results, if the promises already being made to sell at 0·3d. per unit (as in a case we have heard of) are to be fulfilled. Roughly speaking, the receipts are 2¼d. per unit at Liverpool; of this 1¼d. is taken up by cost of production, leaving 1d. to cover financial charges and provide net profit.

Cost of Production.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Increase.
Coal, and unloading same..	£10,116	·42d.	£28,944	**·601d.**	+·181d.
Oil, waste, water and engine room stores	1,636	·07d.	3,172	**·066d.**	−·004d.
Salaries and wages incurred in generation and distribution	5,913	·25d.	9,173	**·190d.**	−·060d.
Repairs and maintenance buildings, boilers, engines, dynamos, &c.	4,729	·20d.	4,704	**·098d.**	−·102d.
Works cost ...	£22,394	·94d.	£45,993	**·955d.**	+·015d.
Rent, rates and taxes ..	3,577	·15d.	6,707	**·139d.**	−·011d.
Management expenses, salaries of managing engineer, secretary, clerks, &c., management of Corporation stock, and auditor's fees	4,947	·21d.	5,836	**·121d.**	−·089d.
General establishment charges, stationery and printing, law charges and insurance	2,204	·09d.	1,296	**·027d.**	−·063d.
Other expenses: Repairs of property, certification of meters, and stamp duty	426	·02d.	460	**·009d.**	−·011d.
Total costs ...	£33,548	1·41d.	£60,292	**1·251d.**	−·159d.

In last year's analysis we have included the sum of £2,000 paid into the city fund as a portion of the net profits. Including this, the total profit is £5,497, against £9,616 in the previous year. This fall of £4,119 is accounted for by an increase of £13,641 in the financial charges, only partly covered by the rise of £9,522 in the gross profit. Considering the low average return per unit and the coal bill, over which increase in price Mr. A. B. Holmes, the city electrical engineer, had no control, we consider the results of last year's working compare favourably with those of preceding years, when Liverpool held its own in the race for efficient management and economical production.

Profit Statement.

	1899.	1900.
Interest on loans	£18,618	£26,148
Sinking fund for repayments	11,722	17,833
Net profit, contribution to city fund*	—	2,000
" carried to renewal fund	9,616	3,497
Gross profit	£39,956	£49,478

* Under head of "Management" in the accounts.

Whitehaven Corporation Electricity Accounts.

The works at Whitehaven are not large, but many of the more ambitious undertakings do not yet show as good results. Mr. E. W. Dunton, the borough electrical engineer, and Mr. J. S. Brodie, the borough engineer, jointly and severally may be congratulated on such figures as those set out below. Probably the only unsatisfactory feature, for which the engineers are not responsible, was the breakdown of dynamos in 1900, resulting in the street lighting being kept off until the load on the station had decreased sufficiently to allow of this load being put on. At this time, however, we only deal with the years 1898 and 1899, for which accounts have been published.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£20,212	**£23,821**	£3,609
Number of units sold	206,364	**218,894**	12,530
Number of public lamps	438	**450**	12
Maximum load in KW.	180	**190**	10
Gross revenue	£3,243	**£3,737**	£494
Gross expenditure	£1,808	**£2,206**	£398
Gross profit	£1,435	**£1,531**	£96
Average price per unit sold ...	3·66d.	**3·97d.**	+·31d.

In 1899 nearly 92,500 units were taken by the street lighting; about 126,400 being sold to private consumers by meter and under contract at rates of 5d. per unit for lighting, and 2d. for "power and heat." The revenue per unit shows an increase of ¼d., presumably owing to the operation of the rates of charges, and the class of consumers who came on during that year.

Revenue Statement.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase
Sale of energy	£3,151	3·66d.	**£3,618**	3·97d.	+·31d
Meter rents	48	·06d.	**54**	·06d.	·00d.
Sale of materials and lamps ..	15	·02d.	**26**	·03d.	+·01d.
Sundry: Interest and rents ..	29	·03d.	**39**	·04d.	·01d.
Gross revenue ...	£3,243	3·77d.	**£3,737**	4·10d.	+·33d.

For an output of under 220,000 units from a works not particularly favourably situated, the costs are exceedingly good. The total capacity installed of 210 KW. was spread over six generating sets, and the economy may be due to the careful attention paid to size and type. Changes in coal and wages mutually cancel out, leaving repairs to swell the works costs by ¼d. Salaries and establishment charges having risen, bring the total cost up by ⅛d., but the figure is still under 2¼d.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£399	·47d.	£490	·54d.	+·07d.
Oil, waste, water and engine room stores.	72	·08d.	71	·08d.	·00d.
Salaries and wages incurred in generation and distribution, and attending public lamps.	503	·59d.	475	·52d.	—·07d.
Repairs and maintenance of engines, buildings, boilers, dynamos, &c., and renewals of street lamps.	484	·56d.	684	·75d.	+·19d.
Works costs ...	£1,458	1·70d.	£1,720	1·89d.	+·19d.
Rent, rates and taxes ..	142	·16d.	122	·13d.	—·03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c. commission, audit fees, and bonus.	204	·24d.	283	·31d.	+·07d.
General establishment charges, stationery and printing, law charges and insurance	4	·00d.	81	·09d.	+·09d.
Other expenses	—	—	—	—	—
Total costs ...	£1,808	2·10d.	£2,206	2·42d.	+·32d.

The sum required for sinking fund and interest was the same in 1899 as in 1898. The revenue having increased by £96 more than the expenditure, caused the net profit to rise in the same proportion, that is, in 1899 the profit was rather more than double the figure attained in the previous year. This result was due to the increase in revenue per unit balancing the increase in cost of production, so that the additional output yielded its due amount of profit.

Profit Statement.

	1898.	1899.
Interest on loans	£543	£540
Sinking fund for repayments	801	804
Net profit carried forward	91	187
Gross profit	£1,435	£1,531

CITY NOTES.

St. Lawrence Power Company.

Mr. Macrae presided on Wednesday last week at the Cannon Street Hotel over a meeting of the debenture holders of the above company. He said that the committee appointed had thought it well to call the meeting as it was nearly a year since they met together for the purpose of raising additional capital for the work, and there had been no report or statement as to what had been done since then. That was not an ordinary meeting, but inasmuch as the capital was contributed by them, they thought they would like to know how things were going on, for he had received numerous letters from time to time from debenture holders anxiously inquiring as to what was being done. By immense efforts on the part of all concerned the additional capital had been raised. They were not informed of the want of capital till the very last moment, and had it not been raised within a few weeks, disaster would have resulted, and consequently a few of them used almost desperate efforts to carry the matter through. Accordingly some of the stockholders had not contributed any of the additional capital, but it was hoped at no distant date to bring forward a proposition to put the matter on a more equitable footing, asking the stockholders who had held back to contribute *pro rata* to the funds. The Committee had devoted an enormous amount of time and energy to the work, and in accordance with the wish expressed, he decided to himself visit America and see the works. Accordingly he went at the latter part of August, and was exceedingly glad that he had done so, for it was of the utmost importance that someone should go. As they knew, the debenture holders were left like sheep without a shepherd. The president of the company, Mr. Moring, who had introduced most of them to the undertaking, and had assumed entire control of it, was absent in the Far East at the time the trouble came. Under those circumstances the bondholders felt that it was essential that a change should be made in the presidentship of the company, and one of the things he had to do was to see this carried out. He might say at once that having made several changes in the directorate, it was ultimately felt that he should be called upon to take the office of president, and he consented to do so, with the object of serving the common interests, but he did so on one stipulation, which was, that if a gentleman resident in America of sufficient position and competency could be found, he should retire. He did that because he felt that the president of the company ought to be a resident in America. Large questions of principle arose as to which the president must have the final decision, and it was better to have someone who was on the spot who could interview people and bring influence to bear. What struck him when he came to look into the affairs in America, was that, although the whole of what he might call the physical side of the work—the construction of the works at Massena—was being carried out in the most efficient manner, the commercial side of it, on which they had to depend for their profits in the future, was not in a very satisfactory position. He did not find on the board people of leisure and with the qualifications to deal effectively with that part of the subject. They were all honourable men, and men of good position, but not men who could devote their time towards forwarding the undertaking in the way of endeavouring to obtain the sale of power. Well, they resolved to appoint an executive committee, and they appointed on it two gentleman to look to the special work of selling the power. He found to his great surprise that the undertaking was practically unknown in business circles in New York, and accordingly they got out a pamphlet illustrating what they were doing, and this had had most gratifying results, for they had had visits from many engineers from all over the country. Then they took a party of journalists on a trip to Massena, with good results. He might say that with regard to one of the men they had put on the board to look to the canvassing, they had already had a proposition for dealing with the whole of the power available, and that was now being considered. He was not prepared for the works he saw at Massena. They were on such a scale and of such magnitude as to cause astonishment. It was a great works, and the scene of activity presented was remarkable. Over a strip of country separating the St. Lawrence River and the Grass River they had a canal of three miles length with branches on either side, and there an army of workmen were to be seen in ceaseless activity, while he was told by independent engineers that the plant being used was unsurpassed in America. As regarded the electrical part of the work, that of course was not set up, but many of the generators and turbines were on the spot and were in process of being placed in their respective positions. The work would be the finest of its kind in the world, and the whole of the power would be controlled by one man standing on a platform and touching different buttons. He was satisfied that the work would be completed in the course of the year, and probably before the fall. As regarded the sale of power, he was not able to report any actual sale yet effected, but negotiations were pending. As to their prospects, he had just read an extract made from the report of a Government engineer of the United States to Congress, viz.:—"The St. Lawrence Power Company have nearly completed their works at an expenditure of nearly 4½ million dollars, and 35,000 H.P. will be available, which can be furnished at such a low price that commercial undertakings will undoubtedly establish themselves in the vicinity of Massena; these industries will create considerable commerce of a general rather than a local character, and this is, in my opinion, assured." He personally had no doubt as to the ultimate success of the undertaking. It would be longer coming than they were at first led to suppose, but he was greatly encouraged by the reports they had received lately, and he believed that before they were in a position to deliver power they would have contracts for taking it.

Mr. Faithful Begg moved a vote of thanks to Mr. Macrae for the immense amount of work he had done for the debenture holders. He had seen the works, and was satisfied that they would be a success. While they were installing 35,000 H.P. yet there was practically no limit to the power which could be developed.

Mr. Simpson seconded the motion, and it was carried.

Replying to a question, the Chairman said they had enough money to finish the works, but they must sell power to keep the works going.

Babcock & Wilcox Company.

The first annual report (since reconstruction) of the directors, being for 1900, to be submitted to the meeting to be held on the 10th inst., states that the net profit, after deducting depreciation on plant, &c., amounts to £155,764. Deducting interim dividends to June 30th last (paid on October 1st) of 6 per cent. per annum on preference shares, and 1s. per share on ordinary shares, issued in exchange for holdings in the old company, there is a balance of £130,764. The directors recommend dividends for the half-year ended December 31st last of 6 per cent. per annum on the preference shares and of 15 per cent. per annum on the ordinary shares. They also recommend placing to a dividend equalisation fund £30,000, leaving a balance of £58,014, of which the proportion of profit accrued from January 1st to April 30th last (the latter being the date of registration of the company after reconstruction) has to be applied in reduction of property account. This amounts to £42,335, leaving to be carried forward £15,679. In addition to the above a premium of 10s. per share on the 90,000 ordinary shares issued has been received, amounting to £45,000, which it is proposed to carry to a reserve fund. The reconstruction of the company has been completed, and all the new shares allotted. It was found necessary, owing to the expansion of the business, to obtain larger office premises, and consequently the head office has been removed to Farringdon Street. The directors have also extended the works to provide particularly for extension of business in the company's patent water-tube boilers for marine purposes; these extensions are now practically completed.

Anglo-Argentine Tramways Company.

The report of the directors for 1900 declares a dividend of 4 per cent. for the year, and states that the permanent way renewals have been reduced to a minimum, only absolutely necessary work being undertaken in view of the entire renewal of the system for electric traction. In accordance with the statement made by the chairman at the last general meeting, it has been decided that the unissued

portion, amounting to £36,600, of the permanent 6 per cent. debenture stock, 1888, shall be issued, and the proceeds paid to the Argentine Electric Traction Company, Limited, towards the total cost of entirely renewing the 40 miles of this company's lines, for the renewal of which only partial provision was made in the specification referred to in Clause 8 of the agreement of April 10th, 1899. The conversion of the company's system to electric traction is proceeding, and the directors are assured by the Argentine Electric Traction Company, Limited, that the work is being pushed on as rapidly as is consistent with reliable construction and equipment.

Wycombe (Borough) Electric Light and Power Company.

The annual meeting of this company was held at the offices on Thursday last week, Mr. Alfred Slatter presiding. The directors' report for 1900 stated:—

The progress made by the company has been very satisfactory, the connections having increased from an equivalent of 7,636 to 16,910 8-c.p. lamps. These figures include current supplied for motors, which have increased from 180 h.p. to 256 h.p. The result of the year's trading, including a balance brought forward of £375 10s. 2d., shows a profit of £2,715 5s. 2d., and after paying interest on debentures and loans amounting to £1,493 10s. 6d., and writing off £194 1s. 10d. preliminary expenses, there is a surplus of £1,027 13s. 4d. The directors recommend the payment of a dividend at the rate of 4 per cent. for the year, and that £400 be placed to a reserve fund for renewal of plant, leaving a balance of £42 13s. 8d. to be carried forward to next year's account. Considerable additions to the plant have been made during the year, and the mains have been largely extended. Further large additions to both plant and mains will be required during the current year to meet the increasing demand, making a further issue of capital necessary. A resolution will be submitted that the capital of the company be increased to £50,000 by the issue of 4,000 shares of £5 each.

The Chairman, in moving the adoption of the report, said that the report was very satisfactory, for the directors had not anticipated that there would be more than 12,000 connections at the end of the year. The high price of coal had prevented the profits from being larger. The number of lamps now connected to the mains is 18,115, and 1,460 were in sight. Mr. Salthouse, the engineer and secretary, was leaving the company to take up a better appointment.

Mr. Birch seconded the motion, which was carried, as were several other resolutions, re-electing directors and increasing their remuneration, re-electing auditors, and increasing the capital.

National Electric Wiring Company.

The fourth ordinary general meeting of the shareholders of this company was held on Monday last at the Westminster Palace Hotel, S.W., Mr. R. Stewart Bain presiding.

In moving the adoption of the report, the Chairman said he was glad to be able to congratulate the shareholders upon a comparatively successful year's working. They would recollect that last year they met together as a dividend-paying company for the first time, the dividend, it was true, being small, viz., 3 per cent., but it was a beginning, and he expressed the hope that it would be the promise of larger dividends in the future. This year, it would be seen by the accounts, they had advanced to a 4 per cent. dividend, which they might say was not a very large increase; but still it was an increase, and he would point out that it was better than it looked, for the dividend of 4 per cent. for this year was upon a paid-up capital of £75,000, and upon the earnings of the work for one year, after making adequate provision for depreciation, whereas the 3 per cent. last year had been upon a paid-up capital of £50,000, and made up by the accumulated earnings of two years. The report showed the business of the company to be a steadily increasing one. During the year 2,240 installations, with an aggregate of 57,519 lamps of 8-c.p. had been completed, as compared with 1,970 installations and 51,774 lamps in the previous year, showing an increase of 270 installations and 5,745 lamps. Of these there had been 777 installations, with an aggregate of 19,973 lamps, free wired, and 1,463 installations, with an aggregate of 37,546 lamps, were contract, while the orders they had in hand at the end of the year were 590 installations, with an aggregate of 33,084 lamps, being an increase of 195 installations and 2,072 lamps as compared with last year. During the first three months of the current year additional orders had been received for 577 installations, with an aggregate of 16,897 lamps, the value of contract work taken being about double the value taken for the corresponding period of last year, which all pointed to the steady increase in the company's business. The installations had not increased in number, but were increasing in importance. He had a list containing over 100 installations which had been carried out with every satisfaction, many of them being for the complete equipment of large works with plant for power and lighting, and he was glad to say the prospect for that class of work during the present year was very hopeful. The free wiring portion of the company's business had not increased in the same proportion as their contract, but that was because of the policy of the board to sink the capital of the company only in remunerative installations. Contracts had been entered into with Swansea, Poplar and Coatbridge, all of which promised to prove profitable undertakings, both as regarded free wiring and contract work. The accounts showed that the gross profit for the year was £9,636, as against £5,648 for the previous 12 months. Their total capital expenditure up to date on free wiring installations was £33,178, of which £12,000 had been expended during the past year, so that the £2,120 revenue was really derived from the capital expenditure with which they started the year, about £21,000. That worked out at about 10 per cent., and was satisfactory. They took over some free wiring contracts from the old syndicate which had not been remunerative, but the whole of their later contracts had turned out to be very satisfactory. The profit from contract work was £6,864, as compared with £3,368 in the previous year, which was more than double. Their total expenditure had been £5,642, as compared with £3,862 in the year previous, so while their gross profits had increased 75 per cent., their expenditure had increased by only 46 per cent. It would be noticed that the directors had relinquished half the fees due to them in accordance with the articles of association, for they would remember that the board stated that until the shareholders received a 5 per cent. dividend they would not receive their full fees, and he thought they were not far from being able to pay that amount. The result of the accounts was a balance of £3,953, which, after allowing for adequate provision for depreciation, enabled the directors to pay a dividend of 4 per cent. and to carry forward £384, which was about £100 more than the previous year. The paid-up capital of the company, which had been increased from £50,000 to £75,000, left a call of 5s., and owing to the satisfactory increase of the company's business, it might perhaps be necessary to call up the remaining 5s. during the present year. In conclusion, the chairman said the progress the company was making was satisfactory, not only in the amount of business contracted, but in the efficient manner in which they carried out their work, which would enable the company to undertake very valuable and important Government contracts.

Mr. B. Bernheim seconded the motion, and the report was adopted.

The two retiring directors having been re-elected, a vote of thanks to the chairman for presiding concluded the proceedings.

Winchester Electric Light and Power Company.

The directors' report for 1900 states that they are well satisfied with the progress which the company has made during the year. An equivalent of over 5,000 8-c.p. lamps has been added during the year, making the total connection at the end of the year 15,126 lamps. Applications for a further 2,300 lamps have already been received this year. Including the balance brought forward from last year's account of £121 5s. 8d., the account shows a net profit of £1,609 1s. 7d. After payment of debenture interest, £933 17s. 9d., and writing off the whole of the preliminary expenses, amounting to £197 17s. 4d., there remains a balance of £477 6s. 6d. available for dividend on the ordinary shares. The directors recommend that a dividend be declared at the rate of 3 per cent. per annum on the ordinary shares, which will absorb £333 16s., leaving a balance of £143 10s. 6d. to be carried to the next account. The system of free wiring, to which reference was made in the last report of the directors, has proved a success, especially since the introduction of the 1s. in the slot meter.

The annual meeting was held at Winchester on Tuesday, March 26th. Mr. F. E. Gripper presided. In moving the adoption of the report, he alluded to the fact, that during the year they had had to contend against the very high price of coal. With the falling prices, and the extra number of lamps that would be fixed during the ensuing months, approximately 5,000, they might confidently hope that their dividend next year would reach 5 per cent.

Major-General Montgomery, seconded the adoption of the report. This was agreed to, and the dividend declared.

Brush Electrical Engineering Company.

The twelfth annual meeting of this company was held on Friday of last week at Winchester House, Old Broad Street, E.C., Mr. J. B. Braithwaite, jun., presiding.

The Chairman, in moving the adoption of the report, having gone at some length into the various items of the balance-sheet, said that with regard to the profit and loss account, they would notice that the gross profit on trading, after making a reserve for doubtful debts, was £50,135, to which was added the £6,496 received by way of dividends on their securities, and the profits realised on sales of some of them, bringing a total credit to revenue of £56,600. He thought that was a fairly satisfactory figure, considering the difficulties under which they had had to labour to some extent during the past year. Those difficulties had been twofold, for in the first place, they had had very high prices for iron, steel, copper, and other raw materials they used, and in the second place, they had had the exceptionally high prices of coal, which had affected their profits to the extent of about £1,000 for the year. The most serious interruption to their work and diminution of their profit during the past year had been the completion of their extensions at Loughborough, and the bringing of their tools into the new shops, and setting them to work. It was a great satisfaction to him to announce that those extensions of the works, and the unsettlement resulting from the same, might be considered as being practically at an end, and they might look forward to reaping the benefit of their capital expenditure on new works during the current year. They had already begun to reap that during the last three months of 1900, but for a greater portion of the year they had suffered seriously from the disorganisation of work, which was unavoidable, in shifting from one shop to another, simultaneously when conducting manufacturing operations. They had also suffered from a change of managership at the works, likewise rendered unavoidable, as circumstances had occurred

affairs in America, was that, although the whole of what he might at the last general meeting, it has been decided that the unissued

which obliged their previous manager, Mr. C. E. Hodgkin, to resign his position and take up another post. He was glad to say, however, that they still retained the benefit of his services, because he had accepted a seat on the board, which would no doubt be of considerable advantage to them. The directors had naturally taken great pains to endeavour to secure a first-class successor to Mr. Hodgkin, and they believe that in Mr. Leeson they had a gentleman who would be able to show them what the new works were capable of doing in the way of manufacturing at a satisfactory profit for the company. Mr. Leeson had not had an opportunity of showing them what he could do in that way on the past year's accounts, but during the present year, if they were able to keep the works fully supplied with orders, there was little doubt they would be able to show figures as to the gross profit earned which would be extremely satisfactory. The new car shops were now completed and fully equipped for work. They covered about five acres of ground, and had a capacity for turning out a large number of electric cars completely equipped. He had mentioned, when they met on the occasion of approving the agreement of the British Electric Traction Company, that the company was now in a position to turn out electric cars of British manufacture throughout, that was to say, they manufactured at their works not only the car bodies, but the motors, the controllers, the underframes, and the trucks themselves, which hitherto had been almost exclusively of foreign manufacture. They were, therefore, now in a position to turn the whole article completed from the company's works, which put them in a very satisfactory position for the undertaking of traction work in this country. Another important event which had occurred during the past year was the agreement which they had entered into with the British Electric Traction Company, for the approval of which a special meeting of the shareholders had been called last January. The agreement had only been in force for a short time, but there was every indication that their expectations in regard to it were to be realised, and that the agreement would be one of mutual benefit to the two companies. He believed that it would bring a large and increasing stream of orders for engines and generators, and also for electric tramway rolling stock, into the company's works, at satisfactory prices, and he had no doubt when they met again next year he should be able to inform them that the agreement had had no unimportant share in bringing about the satisfactory results which he thought they would have to report to them on future occasions. As to a further issue of shares, they would remember he told them last year that in order to complete their works and carry out all the extensions they had in contemplation they would require to issue about 30,000 preference shares and 30,000 ordinary shares, which at par would represent £120,000 of additional capital. They offered them to the shareholders, and almost exactly one-half was taken up by them, that was £60,000 of the £120,000 which they had estimated they would require, and that was all they wanted for the time being. Now, however, that their works were completed it was necessary to obtain the remaining £60,000, and for that purpose they intended issuing a further 12,500 preference shares, which at par value would represent £25,000, and 20,000 ordinary shares, representing at par value £40,000, making a total additional capital issue of £65,000, so that their original estimate had in that case been pretty accurately borne out by facts, there being only a difference of £5,000 between the amount proposed to be issued now and the amount they estimated a year ago as being necessary to close the capital account for the time being, and to pay for all the extensions and additions to the works.

Mr. C. E. Hodgkin seconded the resolution, and the report was adopted.

Woolwich District Electric Light Company.

The directors' report submitted to the annual meeting held on Monday, March 25th, reads:—

The directors beg to present their annual report and statement of accounts for the year ended December 31st, 1900. The progress of the company during the year has been very gratifying, the increase in lamp connections having risen from 9,610 to 19,425, and the sale of current having increased from £3,372 in 1899 to £6 109 in 1900. The result of the trading for the year including £68 10s. 3d. brought forward from last account, is £2,788 15s. 0d., which, after payment of debentures and loan interest, amounting to £762 6s. 3d., leaves a profit to be dealt with of £2,026 8s. 9d. The directors recommend that a dividend be paid at the rate of 5 per cent., absorbing £1,022, that £600 be placed to the renewal fund, and that the balance be carried forward to next account. During the year the works have been largely extended, a lease having been obtained of additional ground adjoining the works. A new 250 kw. dynamo set has been added, and additions to the boiler power, whilst the mains have been considerably extended. Further capital being required to meet the continued increase in the company's business, a resolution will be submitted that the capital of the company be increased to £50,000 by the issue of £25,000 shares of £1 each, which will be offered *pro rata* to the shareholders. Of the directors, Mr. J. C. Wigham retires by rotation, and being eligible, offers himself for re-election.

Mr. J. A. Findlay presided at the meeting, and in moving the adoption of the report, pointed out that compared with the previous year, while the sale of current has nearly doubled, jumping from £3,372 to £6,109, the expenditure had only gone up by a little over £700, and that if the price of coal had remained the same last year as it was the previous year, these expenses would have been £500 less. As the price of coal has gone down, a saving will be made in this item this year. The capital account shows a large increase, which is due to the great extensions of the company's business. In the past, the company had passed through a number of lean years; now they had entered on something more in the way of fat years, and there was every prospect of the improvement continuing.

Mr. Gripper (director) seconded the adoption of the report, and pointed out that the number of lamps connected were doubled in 1899, were doubled again last year, and although they could not expect to have them doubled this year, there certainly should be a very considerable increase.

After the routine business of the meeting had been attended to, a special resolution was submitted by the chairman:—"That the capital of the company be increased to £50,000 by the issue of 25,000 shares of £1 each," and he remarked that the company owed their contractors a large sum of money, and that this issue was intended to put the accounts of the company in better order. When the shares are issued, there will be sufficient to pay off the amounts due to the contractors and leave sufficient in hand for this year's capital expenditure. He said he might inform the shareholders that they had been approached by the Council of the Borough of Woolwich with reference to the sale of their undertaking, and that if they were made an offer by the Council which they considered reasonable and a suitable one, they would call the shareholders together to consider it. Having got a very sound concern, they were not by any means inclined to part with it except at its full mercantile value.

County of London & Brush Provincial Electric Lighting Company.

The seventh ordinary general meeting of the proprietors of this company was held on Thursday of last week, at Winchester House, Old Broad Street, Lord Rathmore (chairman) presiding.

In moving the adoption of the report, the Chairman said it was a great satisfaction to his colleagues and himself to find that they had reached the stage in the progress of the company, to which they had through past years of difficulty, and sometimes of disappointment, looked forward; he meant the stage at which they were able to recommend the payment of a dividend, which was to a large extent provided out of the earnings of their London stations. Last year they were able to recommend a dividend from the profits realised by the sale of their interest in one of their subsidiary undertakings, but this year they were able to recommend the same dividend without the further sale of any of the interests in their subsidiary companies. Their Metropolitan stations had always been, and must always be, the backbone of the company's business, and it was to that part of the business that they must look in the future for the permanent, and he hoped increasing, rewards for their investments, and therefore it was a great satisfaction to all of them, that they had arrived at that stage in the history of the company. As to their associated companies, at Bournemouth last year the number of applications for current was very large; they amounted to more than 10,000. That had been considered by the Bournemouth Company a record year in their history, but this year they had contrived to go a shade better. There was also another feature, that the work of the construction of a tramway between Bournemouth and Poole was now completed, and no doubt the Bournemouth and Poole Supply Company would presently be called upon to supply the current for the working of the line. The revenue account of the Bournemouth and Poole Company had also advanced in a very satisfactory manner, which was all encouraging because it had been accomplished in spite of the great disadvantage of the high price of fuel which prevailed during the greater part of the year. The result was that they had been able this year to pay a dividend of 6 per cent. on the ordinary shares, as against 5 per cent. last year. As to the Dover company, he did not think he could add anything to what had appeared in the report. There, too, had been substantial progress in the number of lamps applied for, and also in the demand for power and current for public purposes, the result being that their dividend was increased from 3 per cent. to 3½ per cent. As to Coatbridge, he must confess that up to the present, that station had been the least successful of their ventures, but during last year a great change for the better had taken place. The number of consumers of current had more than doubled, and the number of lamps applied for had increased by nearly 90 per cent. The company had lately arranged terms with the neighbouring town of Airdrie for a transfer from the Airdrie Corporation of their lighting order; and an agreement had been entered into for both the public and private lighting of that town. At the same time, the interest of the Airdie and Coatbridge Tramways Company had also been acquired, and this year a provisional order was being applied for, with the consent and assistance, he believed, of the Coatbridge Corporation for the construction of tramways in Coatbridge. If, as there was every reason to expect, those plans should be successfully carried out, an entirely new prospect would be opened up for the Coatbridge station, which had hitherto rather languished for want of work. Turning to their London stations, they would remember that when he addressed them last year he called their attention to the fact that the Western Holborn and Camberwell districts were comparatively unproductive. He was glad to say that since that time those districts had turned out extremely well. The figures for Western Holborn were £2,206 for 1900 as against £470 for 1899, and for Camberwell £4,750 for 1900 as against £941 for 1899. That increase had fully come up to the expectations which the directors entertained that time last year, and he thought it gave very promising prospects for the future. At the City Road station the profit for 1900 showed an increase of 98 per cent. over the figures of the previous year, and the average works costs at that station had been steadily reduced from 3·8d. in 1898 to 2·4d. in 1899, and last year they were only 1·8d. That result was particularly creditable in a year when they had to contend with the abnormal high price of fuel. Another very satisfactory feature was the rapidly growing demand for current for power purposes, the increase for the year having been a demand for the equivalent of 798 h.p., while the applications up to date represented equivalent of 1,941 h.p. It was in consequence of the rapid growth of that branch of the company's business that it had been

which £12,000 had been expended during the past year, so that the £2,120 revenue was really derived from the capital expenditure

likewise rendered unavoidable, as circumstances had occurred

found necessary to increase their plant at City Road. The increase of profits for their Wandsworth station did not at first sight appear to be as satisfactory as those at the City Road, although they showed an increase of 40 per cent. When they remembered, however, that in the year ending December, 1899, one-fourth of the total output from Wandsworth was for current sold to the South London Company, while during last year they did not sell a single unit from the station to any other company, and when they saw that they had notwithstanding made up the whole of that leeway, and now showed an increase of 40 per cent., he thought they would agree that the results from their southern station were hardly less satisfactory than those from their northern station. So far as they had gone in the current year, the applications received compared in 8-c.p. lamps very favourably with those received in the corresponding period of 1900; that was to say, up to March 5th, 1900, they were for the two metropolitan stations 12,427, and up to March 5th this year they were 15,566. Again speaking of the two London districts together, the number of applications which they had received for current during 1900 amounted to the equivalent of 102,000 8-c.p. lamps, which he believed was the largest number received by any London company during that year, and the units sold were 2,990,138, as against 1,766,515. He would also like to add that the net revenue of the company, excluding profits on investments realised, had shown extraordinary progress during the last two years, having grown from £7,285 in 1898, to £13,441 in 1899, and to £27,526 in 1900; that was to say, the net revenue had practically doubled itself in each of those years. Concluding, the chairman said he thought the shareholders might heartily congratulate themselves, not only upon the rapid progress which the company had made during the past year, but also upon what he believed to be its encouraging prospects.

Mr. J. B. Braithwaite seconded the motion, which, after some discussion, was carried unanimously.

South London Electric Supply Corporation.

The directors' report for the year ending December 31st, 1900, reads as follows:—

The board of directors have pleasure in presenting their report and accounts for the year 1900. On December 31st, 1899, the company were supplying current to the equivalent of 25,625 lamps of 8 c.p. On December 31st, 1900, this number has increased to 43,322. At the present time there are on circuit the equivalent of 45,482 lamps of 8 c.p., and applications have been received for a further 2,890 lamps. There has, of course, been a large consequent increase in the revenue, although, as a great proportion of the additional lamps were not applied for and connected until the autumn, this increase is not so apparent as it will be in the present year. It shows, however, on the accounts that the company has now reached a profit-earning stage, which, having regard to the general experience of electric light companies in the earlier years of their work, is decidedly satisfactory. Had it not been for the unusually high price of coal during the greater part of the year, the net balance of profit would have been considerably larger. The length of roadway in which mains have been laid is now 41 miles, comprised of 48 miles of high tension, and 38 miles low tension ways, in which 32½ miles of high tension and 38 miles of low tension cable have been laid. These figures only denote feeders and distributors, service connections not being included. The erection of the remaining plant provided for under the various contracts has satisfactorily progressed during the year. At the end of October last the dust destructor had to be shut down, in consequence of proceedings taken by the Lambeth Vestry for alleged effluvia from the chimney. In going through the accounts the shareholders will doubtless note with satisfaction the great increase in revenue derived from the sale of current. To give the shareholders an opportunity of seeing their works, now in full operation, it has been thought well this year to hold the meeting at the offices of the company, at the generating station. In accordance with the articles of association, two of the directors, Alderman George Ellis, J.P., and Mr. Jacob Atherton, retire, but, being eligible, offer themselves for re-election. The auditors, Messrs. Price, Waterhouse and Co., also retire, and they being eligible, offer themselves for re-election.

sure that they would agree that it had already proved a success. He would mention that their consumers were evenly divided all over their area in which they had powers, and that notwithstanding that a large number of these consisted of small shops and residences, led them to hope that the normal increase would be as steady and widespread as the work which had been done up to the present. No effort had been spared to obtain business by circularising and personally canvassing the inhabitants. Owing to the preponderance of the small property in their district, the increase in the use of electric light was sure to be gradual, and it would therefore, in the ordinary course, be some time before they could see the demand come up to the capabilities of their station. The directors had before them certain proposals, to which at present he was not at liberty to more fully refer, but which, if carried through, would produce an immediate and very large increase in the consumption. If those negotiations were completed, as he hoped they would be, they would be able to congratulate themselves on a very valuable addition to the company's business. They had no doubt noticed the remarks regarding the shutting down of the dust destructor in the report. He would state that it had not been possible to arrive at any reliable result as to the precise value of the destructor as a steam-raising factor and fuel economiser, and that regrettable incident had occurred just at a time when the refuse was becoming of a combustible nature and at a period when it would have demonstrated its utility more effectually. The Lambeth Vestry had first insisted on the erection of the destructor as being a necessity in such a crowded district as the whole of Lambeth, and therefore it had been built and worked on the most modern principles and with the utmost care. But as soon as it had got to work, the Vestry obtained an order to close it on the ground that residents in the district complained of it. The company had given instructions for the erection of an economiser and condensing plant, for the purpose of making provision for the utmost economy in the generation costs, and the economiser was now complete and in operation, and had already effected a very considerable saving in the consumption of coal. The condensing plant was in the hands of the contractor, and was being pushed forward rapidly. With respect to the thermal storage plant, there had been considerable delay owing to the non-delivery of the vessels, but these were now in a position for the plant to be completed forthwith. During the last three years the company had been passing through a very unproductive period which had characterised the progress of every electric lighting undertaking. There had been a succession of difficulties, but the directors were confident on having now surmounted them, and the business that the company had reached a profit-earning stage, and the directors believed that on the current year's working a dividend would be payable to the shareholders.

Mr. J. Atherton seconded the motion.

The Chairman, replying to questions, said it was perfectly true that their coal bill was very high. That was due, however, to the engines supplied by the contractors being not so economical as had been stated. The matter was pointed out to the contractors who had refunded a portion of the sum paid. The company had now two or three engines which had been proved to be quite as economical as could possibly be obtained. Their plant now was quite large enough to enable them to light 240,000 lamps. Respecting the lighting of the streets of the district, negotiations were in progress with the vestry, and he hoped for good results.

The report was adopted.

The two retiring directors having been re-elected, the proceedings terminated.

Statement of Electricity Generated, Sold, &c. (South London Electric Supply Corporation).

Board of Trade units generated.	Sold to consumers.	Quantity utilised.		Quantity expended in distribution.				Total quantity accounted for.	Quantity unaccounted for.	No. of lamps on circuit, equivalent in 8 c.p. Dec 31st, 1900.
		Used on works for lighting, meter testing, motors, public arc lamps, &c.	Total.	In batteries and motor alternators.	In feeders.	Transformers.	Total.			
1,508,682	9 8,131	322,310	1,250,441	102,997	97,222	104,633	244,852	1,495,293	13,389	43,322

The meeting was held on March 27th at the offices, Bengeworth Road, Loughborough Junction, S.E., Mr. George Ellis, J.P. (chairman) presiding.

In moving the adoption of the report, the Chairman said the accounts which they had placed before them, although they did not show a profit over those of 1900, would undoubtedly have been much greater but for the abnormal price of fuel during the whole of the past year, the increase on that material having been 35 per cent. They would notice that the actual number of lamps added to the circuit had been 17,697 of 8-c.p., and that day the total number stood at 45,863, besides which they held applications for a further 3,552 8-c.p. lamps. Had this increase been spread over the whole of the year the effect on the company's revenue would have been much greater, and as the demand for additional lamps still continued, the profits of the company for the future appeared likely to be satisfactory to all of them. In March of last year the price for current used for lighting purposes was reduced from 6d. per unit to 5½d., and for that of power and heating from 4d. to 2d. per unit. The board had also introduced a scheme for installing six lights on consumers' premises absolutely free of all cost to them, and when he told them that there were as many as 205 consumers wired under that scheme, and in addition to the six lights thus installed, the consumers had added many lights at their own expense, he felt

Liverpool District Lighting Company.

The annual meeting took place in Liverpool on Wednesday last week, Colonel A. H. Holme presiding. The report, of which the principal items were given in last week's Electrical Review, was adopted.

The Chairman remarked that at Waterloo and Crosby the company's business was rapidly developing, the lights having increased from 127 in 1897 to 7,122 at the present time. With respect to the suggestion of purchase by the Waterloo Local Board, the shareholders might be quite certain that the directors would only sell at a profit which would recompense them for the long time they had waited.

Messrs. Harold Cunningham and Holbrook Gaskell, jun., were re-elected directors.

In replying to a vote of thanks, the Chairman said that the directors considered the question of acquiring the local electric tramway, but they thought that they had better stick to their own business. The company had, however, secured themselves absolutely so far as the electric lighting of the company's district was concerned. They could not be overtaken either by the local authority, the Overhead Railway Company, or the Lancashire Power Company.

Dover Electricity Supply Company.

The directors' report, presented at the meeting held at Dover on Wednesday, April 3rd, reads as follows:—

The directors beg to submit their report with balance-sheet and accounts for the year ended December 31st, 1900. The results obtained in the year under consideration must be regarded as satisfactory, having regard to the exceptionally high price of fuel and other materials. The directors considered that in spite of the increase in cost of production, the best interests of the shareholders would be served by making no temporary increase in the price of current. During the year applications have been received for an equivalent of 3,002 lamps, showing a steadily increasing rate of expansion. The output to private consumers shows an increase in 1900 of 30 per cent. over that of 1899; and this rate of progress is fully maintained in the present year to date. The directors have also to report with satisfaction the growing use of electric energy for motive power purposes. Electric motors are in use in the town for a variety of purposes, and others are being installed. As will be seen from the accounts, a considerable capital expenditure has been necessitated during the past year by extension of mains, and the installation of a large direct current set for power purposes. Under the terms of an agreement entered into with the Admiralty Harbour contractors, a large amount of energy will be required for their purposes during the present and the next few years. Further capital in 5 per cent. preference shares was created during the past year, and a small amount thereof issued as required, at a good premium. The steady growth of the company's business will probably render it desirable to issue the balance of these shares during the current year. The directors of the company have been approached by the Dover Corporation with a view to the transfer of the undertaking to the Corporation, but in view of the prospects of the company as indicated by the progress hitherto made, your directors do not advise a sale to be made. The gross profits of the year amount to £2,986 10s. 6d. After paying debenture and other interest, the directors propose to include an amount brought forward from 1899 and recommended in their last report to be applied to suspense account. The net profit account will then show a balance of £1,759 11s. 4d., out of which the directors recommend the payment of a dividend of 3½ per cent. on the ordinary shares. The retiring director is Sir William Crundall, who, being eligible, offers himself for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, but is eligible for re-election.

Stock Exchange Notices.—The Committee has appointed special settling days as under:—Wednesday, April 17th: Baker Street and Waterloo Railway—34,601 ordinary shares of £10 each, fully paid and £6 paid, within Nos. 1 to 34,601; and 66,000 4 per cent. preference shares of £10 each, fully paid and £6 paid, within Nos. 1 to 66,000. The Committee has also ordered the undermentioned to be quoted in the Official List:—W. T. Henley's Telegraph Works Company, Limited.—Further issue of 5,000 ordinary shares of £5 each, fully paid, Nos. 30,001 to 35,000; and 5,000 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 30,001 to 35,000. Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—British Electric Traction Company, Limited.—Further issue of ordinary shares of £10 each.

Anglo-American Telegraph Company.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31st, 1901, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income-tax.

Prospectus.—The Tynemouth and District Electric Traction Company, Limited, closed its list of subscriptions for an issue of 6,000 (£5) 5 per cent. preference shares, on Friday last. The concern is promoted and engineered by the British Electric Traction Company.

Eastern Extension, Australasia and China Telegraph Company.—The directors have declared a dividend for the quarter ended December 31st of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1900. The dividend and bonus will be paid on April 25th.

Eastern Telegraph Company.—The directors announce a dividend of 3½ per cent. per annum on the preference stock for the quarter ending 31st inst., and an interim dividend of 1½ per cent. on the ordinary stock for the quarter ended December 31st last.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending March 29th were £426; corresponding week last year, £376; increase, £50. Total to date, £5,089; corresponding period last year, £4,598; decrease, £491. Miles open, 8½. Partly electrical and steam.

Blackpool and Fleetwood Tramways.—The receipts for the week ending March 30th were £147; corresponding week last year £201; decrease, £54. Total to date, £1,883; corresponding period last year, £2,073; decrease, £190.

Bristol Tramways and Carriage Company.—The receipts for the week ending March 29th were £3,581 4s. 6d.; corresponding period last year, £2,552 3s. 5d.; increase, £1,029 1s. 1d.

Central London Railway.—The receipts for the week ending March 30th, were £6,228; previous week, £6,188; increase, £40. Total receipts to date (13 weeks), £79,235. Miles open, 6.

City and South London Railway.—The receipts for the week ending March 31st were £2,115; corresponding week last year, £1,860; increase, (Moorgate extension open) £755. Total to date, £26,351; corresponding period last year, £15,939; increase, £10,412. Miles open, 1901, 4½; 1900, 3½.

Dover Corporation Tramways.—The receipts for the week ending March 30th were £153 7s. 3d.; corresponding week last year, £145 4s. 9d.; increase, £8 2s. 6d. Total to date, £1,998 5s. 0½d.; corresponding period last year, £1,868 18s. 10½d.; increase, £129 6s. 2d. Miles of track open, 3; Car miles run, 1901, 4,957; 1900, 4,942. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending March 29th were as follows:—D. U. T. Co., electric cars, £2,929 8s. 5d.; D. S. D. Co., electric cars, £620 10s. 0d.; total £3,549 18s. 5d.; corresponding week last year—D. U. T. Co., electric cars, £2,886 13s. 2d.; ditto, horse cars, £48 7s. 10d.; D. S. D. Co., electric cars, £653 11s. 3d.; total, £3,588 12s. 3d.; decrease, £38 16s. 10d.; aggregate to date, £47,416 8s. 7d.; aggregate to date last year, £43,869 13s. 5d.; increase, £3,546 15s. 2d. The mileage worked is 45 miles electrically, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending March 31st were £1,462; corresponding week last year, £1,277; increase, £185. Total to date, £19,906; corresponding period last year, £18,197; increase, £1,069. Miles open, 6 miles 57 chains

STOCKS AND SHARES.

Tuesday Evening.

The Easter holidays, besides necessitating the inditement of this article a day earlier than usual, are preventing business in the Stock Exchange to no small extent. A fair amount has been done in Electricity Supply shares and Traction descriptions, but the dearness of money co-operates with the holiday season in keeping prices down. The general tone this week has remained very steady, and it is better for the market that prices should not fluctuate too sharply. If they do, the investing public looks askance at the erratic movements and goes to some department where a steadier level is maintained. For immobility of price, however, the higher class Electricity Supply division is difficult to beat.

There is still, at the time of writing, no official declaration with regard to the new issue of Debenture stock by the Charing Cross Company, but our hint of last week has not passed unnoticed in the market. The emission may be daily expected. Another new capital appeal is being discussed, the British Columbia Electric offering a large amount of fresh shares. In consequence, the quotations for the old Ordinary and Preference have declined to 6⅞ and 10 respectively. There is a consistent demand for St. James's, Westminsters and Kensingtons, and the available supply of gilt-edged stocks in the electric market grows smaller and beautifully less each week.

Some delay in the issue of the London Electric Company's report has created a bad impression in the Stock Exchange, which is always ready to jump to the conclusion that directors do not keep back their usual statement when they can unfold a flattering tale.

Edmundson's new Preference have just passed through their special settlement. The price of the shares is ½ premium over and above the issue price of 5s. premium. Concurrent with this settlement the Johnson-Lundell Electric Traction shares have also come to account for the first time. The making-up price of the £5 shares, £3 paid, was fixed at 2½ to-day, but the quotation is merely nominal. Buyers could be readily accommodated at 50s., but what figure a seller would get for the shares we cannot tell—certainly considerably less than the making-up price. The market is almost as bad as that for Baker Street and Waterloo Railway shares, in which, by the way, a special settlement has been fixed for Wednesday, April 17th. There is a certain amount of grim irony in appointing a "settlement" in the shares of this London and Globe incubus.

Telegraph securities are void of life, but prices keep up with determination. The market is looking for a very favourable report from the Eastern Extension Company, but hardly likes to put up the shares on the strength of a vague anticipation. Anglo-Americans are a little better market. It is freely stated that the company is suffering only slightly from the German competition, and the declaration of the usual quarterly dividends has had a soothing effect upon nervous holders. Half-a-dozen investments in the telegraph list are now quoted as *ex* dividend—Commercial Cable capital stock being also *ex* bonus—and beyond the alterations produced by this recission there is little quotable alteration in prices.

Its stronger backing is still assisting the British Electric Traction market, and the strength of the price is well maintained. Anglo-Argentine tramways shares remain at 4, although the company's report is not rosy reading. It would appear that the line is by no means electrified as yet, although the directors are assured by the Argentina Electric Traction Company that the work is being pushed on as rapidly as is consistent with reliable construction.

In the electric railway market there is some interest aroused over the statement that at the end of this month the Metropolitan District Company proposes to reduce its season ticket rates, and also to issue "seasons" for third class travellers. This is obviously an effort to regain some of the traffic captured by the Central London, but we doubt whether it will make much difference. Those who have become accustomed to the "Tube" are not likely to return to the dirty District, even though the latter's fares are lowered. Central London proprietors can, therefore, afford to smile, and keep their shares.

Babcock & Wilcox Ordinary have hardened to a trifle over £3 on the issue of the first annual report since the company's reconstruction. Expansion and extension are the keynotes of this document, which provides pleasant food for the thoughts of shareholders.

The manufacturing section is somewhat neglected. National Telephone 4 per cent. Debenture is a dull stock, and can be picked up at 98—perhaps a trifle cheaper. With all the millions of capital behind it, the stock does not seem dear, but the Telephone Company finds few supporters of its shares in these latter days, and there are many more sellers than buyers of its issues.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations March 27th.	Closing Quotation April 2nd.	Business done during week ended April 2nd, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	55 — 65	55 — 65	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	50 — 53	51 — 54	52½	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	94 — 96	95 — 97	96¼	94¼
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	8 — 8½	8½— 8⅝	8⅝	8¼
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3½	3 — 3½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	165 —175	160 —170	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	101 —103 xd	102¼	...
16,000	Cuba Telegraph	10	8 %	7 %	...	7½— 8½	7½— 8½	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10 xd	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 — 104%	100 —104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	3 %	9¾— 10¼	9¾—10¼ xd	9 15/16	9¾
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	143 —148	143 —148	145½	143
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	93 — 96	93 — 96	94	93
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —117	113 —117	113	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	14½— 14⅝	14½— 14⅝	14⅝	14⅝
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) ...	10	...	...	...	13⅝— 14¼	13⅝— 14¼	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	111 —116	111 —116	112½	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	5⅛%	5⅛%	...	9⅝— 10¼	9⅝— 10¼	10⅛	9⅞
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14½— 15¼	14⅝— 15¼	15⅛	14⅞
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	32 — 34	32 — 34	...	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	...	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅜— 3⅝	3⅜— 3⅝	3¼	3⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	10 — 12	10 — 12	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅜— 4⅝	4⅜— 4⅝	4 7/16	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	90 — 93	90 — 93	91¾	91
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	97 —100	96 — 99	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4½— 5	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	97 —100	97 —100	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gus. by Bras. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14½	13⅜—14½ xd	14⅛	13 13/16
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	102¼	...
88,321	West India and Panama Telegraph	10	2 %	8%	...	⅝— ¾	⅝— ¾	11/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅜— 8¼	7⅜— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8¼— 8⅜	8⅜— 9¼	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	9 — 10 xd	9 0/16	9⅛
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅜	5¼— 5⅜	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5⅜— 6¼	5⅜— 6¼	6¼	5 15/16
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	7 — 8	7 — 8	7 0/16	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	12½—13½ xd	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	121 —126	121 —126	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	4 %	8 — 9	8 — 9	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4⅜— 5¼	4⅜— 5¼	5 1/16	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	105	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	3 — 5	3½— 4½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	12 — 13	11½— 12½	12 1/16	12
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	97 —100	97½	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	13½— 14½	13½— 14½	14⅛	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	100¼	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	11½— 12½	11½— 12½	12½	11 13/16

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Mar. 27th.	Closing Quotation April 2nd.	Business done week ended April 2nd, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7½— 8½	7½— 8½	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	15 — 16	15 — 16	...	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11½— 12½	11½— 12½	12⅜	...
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	119 —122 xd	...	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/16— 3/16	1/16— 3/16	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	3/16— 5/16	3/16— 5/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	85 — 90	85 — 90	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	10 — 11	10 — 11	10⅝	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅜— 6½	5⅜— 6½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝— 1⅞	1½— 1⅝	1 1/16	1⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2⅛
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	103 —108	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	15 — 16	15 — 16	15⅛	15
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	8¾— 9¼	8¾— 9¼	9	...
78,703	Do. do. Pref. half-shares	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
78,703	Do. do. Def. do.	5	...	...	...	4 — 4½	4 — 4½	4⅜	4⅛
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	46 — 50	46 — 50	48	47
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4 — 5	4 — 5	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3¾— 3⅞	3¾— 4	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1½— 2	1½— 2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3 — 4	3 — 4	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	87 — 89	87 — 89	88⅜	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	94 — 98 xd	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅜— 2¼	1⅜— 2¼	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½— 3	2½— 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	103¾	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	15 — 16	15 — 16	16	15⅞
35,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½— 6	5½— 6	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	107 —111	107 —111	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3⅜%	3½%	7⅞— 7⅞	7⅞ — 7⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13½	13 — 13¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	37 — 41	37 — 41	39½	38
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	11 — 12	11 — 12	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½— 6	5½— 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	94 — 97	94 — 97	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, 7/16—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—11.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11—12; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7 Debentures, 102—104. Dividend, 1900, on Ordinary Shares 12 %.
*T. Parker, £10 (fully paid), 16½.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (February 21st, 1901).

MARKET QUOTATIONS, Tuesday, April 2nd.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3¾d.	3¾d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5s.	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2' to 12') basis	per lb.	7½d.	7½d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8½d.	8½d.	..
c ,, Wire, basis	per lb.	8d.	8d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£84	£84 10	10s. dec.

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£84	£84 10	10s. dec.
g ,, Rod	per ton	£84	£84 10	10s. dec.
e ,, (Electrolytic) Bars ..	per ton	£82	£82	..
e ,, ,, Sheets ..	per ton	£90	£90	..
e ,, ,, Rod ..	per ton	£84	£84	..
e ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	¼d. inc.
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	3/-	3/-	..
h India-rubber, Para fine	per lb.	3/6½ to 3/7	3/6½ to 3/7	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	45/6	45/6	..
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£13 10	£13 12 6 to £13 15	dec.
g ,, ,, Sheet	per ton	£15	£15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/8	From 1/8	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10¾d. to 1/0½	10¾d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £40	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£117 10 to £118	£119 to £121	dec.
g ,, foil	per lb.	1/9	1/9	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9d.	9d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14	£14	..
k Zinc, Sh't. (Vielle Montagne bnd.)	per ton	£21	£21	..

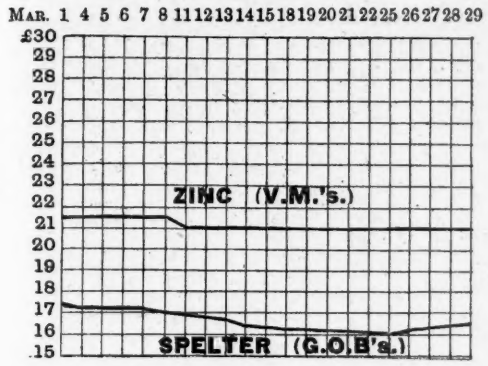
Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

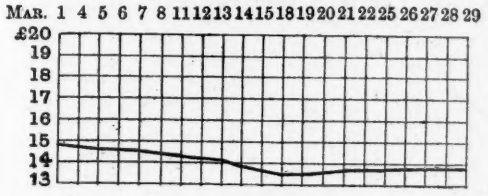
Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

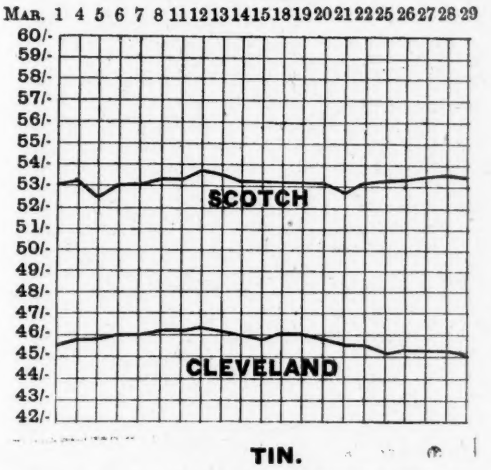
Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

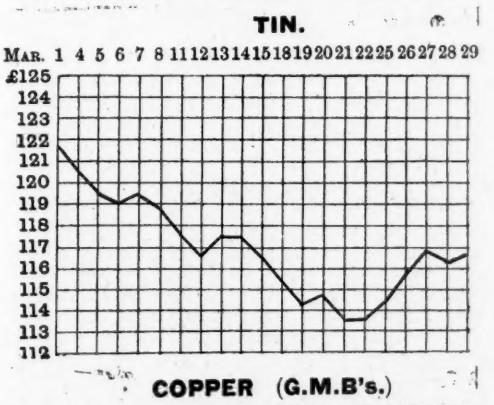
METAL MARKET.

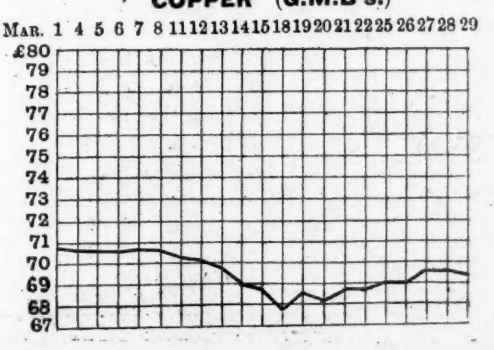
Fluctuations in March.











INSTITUTION OF ELECTRICAL ENGINEERS.

SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.

By A. C. Eborall, Member.

(Abstract of paper read on Thursday, March 14th, 1901.)

(*Continued from page* 560.)

There are two commercial ways of regulating rotary converters, each depending upon the same principle, namely, that of altering the pressure on the slip rings in order to get a corresponding alteration on the direct-current side; as already pointed out, the ratio of the two pressures is practically a constant. The first method consists in varying by hand the impressed pressure on the slip rings, either by altering the ratio of transformation of the step-down transformers, or by means of an "induction regulator." In the first case the step-down transformers are so arranged, in conjunction with a multiple contact switch, that either the number of secondary or of primary turns can be altered by hand; the regulating switches are interlocked, so that the turns are cut in or out simultaneously. It is obvious that this method has several disadvantages, the most serious being those of first cost and difficulty of operation. If the regulation is performed on the primaries, the switches become somewhat difficult and expensive to construct properly, on account of the high pressure of the circuits into which they are connected, while if the regulation is performed on the secondary sides, the expense becomes even greater, on account of the heavy currents to be handled; the difficulties that arise with the contact surfaces of all regulating switches for heavy currents are well known. In addition, there is the difficulty of arranging such switches to regulate gradually, and to avoid short-circuiting the sections of the transformer winding connected to the contacts of the regulator as these sections are being cut out or in.

On account of difficulties connected with insulation, induction regulators should be connected into the secondary circuits of the step-down transformers. As usually constructed, such regulators consist of an iron core arranged in connection with a shunt and series winding in each phase, in such a manner, that a movement of the core will decrease or increase the mutual induction between the two windings. Thus if the core is moved inwards, the pressure on the converter slip rings is reduced, on account of the inductive action of the shunt winding on the series winding, while as the core is moved outwards, the effect of the shunt coils on the series coils becomes less and less, until at the end of the travel of the core the pressure on the slip rings is practically the full pressure of the transformer secondaries. Such an apparatus is easy and cheap to construct, and very effective in operation, a range of 6 per cent., up or down, being easily attained; moreover, it can be readily arranged to be operated from a distance, and having no contacts or moving conductors, is unlikely to get out of order.

A modification of the induction regulator, first devised, the author believes, by Mr. M. B. Field, is shown in fig. 3; it possesses

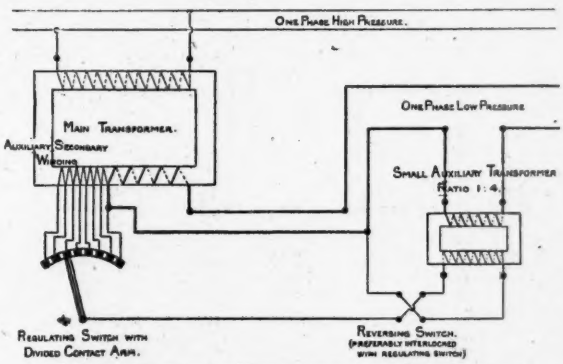

One Phase High Pressure.
Main Transformer.
Auxiliary Secondary Winding
One Phase Low Pressure
Small Auxiliary Transformer Ratio 1 : 4.
Regulating Switch with Divided Contact Arm.
Reversing Switch. (preferably interlocked with regulating switch)

Fig. 3.—Diagram of Connections for One Form of Induction Regulator.

the advantage of being somewhat more efficient than the induction regulator described above. The secondary of each step-down transformer has an extension in the form of some extra turns capable of carrying about 25 per cent. of the full secondary current; these extra turns are connected to a small regulating switch, and to the windings of smaller section of a small auxiliary transformer (with ratio, say, 1 : 4) as shown. The secondary of the auxiliary transformer is in series with the low pressure circuit, and adds or subtracts a small E.M.F. to this circuit as desired. It will be seen that both the voltage and current can be very readily handled, without undue expense, and, moreover, the supply is not interrupted should the regulating switch get out of order.

The second method of varying the impressed pressure on the slip rings of the rotary consists in compounding the rotaries, and providing a certain amount of self-induction between the terminals of the transformer secondaries and the slip rings of the machines by inserting choking coils in the leads. The rotary converters, being synchronous machines, operate at a power factor determined wholly by the field excitation; for each load on the rotary there is

a certain excitation that will make the power factor a maximum. Let now the shunt winding on the fields of a rotary converter, arranged with compound winding, and, if necessary, with small choking coils, be so adjusted that when operating at no load the machine takes a certain amount of lagging current, say 30—40 per cent. of the full-load current, partly due to the under-excitation, partly due to the reactance in each phase. As the load comes on, the field flux increases, on account of the current in the series winding—that is, the lagging current diminishes, and therefore the impressed pressure increases, producing a corresponding rise in the direct current pressure; this strengthens the fields still more (on account of the shunt winding) until a balance between the two pressures is attained. At full load the field flux is at its working maximum; the input current will be by this time leading, due to the over-excitation having wiped out the lag produced by the reactance, and the direct current pressure will be raised to the correct value, on account of the increased pressure on the slip rings. By suitable proportions of the reactance and field windings, excellent pressure regulation can be attained in this way in a perfectly automatic manner; it is perfectly easy to arrange for the direct current pressure to be over-compounded 10—15 per cent., the actual regulation being nearly as good as with an ordinary over-compounded direct current machine,* provided the pressure at the ends of the feeders in the sub-stations is maintained as nearly as possible constant. The only objection to this method of regulation is the influence it has upon the regulation at the high pressure bus bars in the sub-stations.

The extent to which over-compounding of rotaries can be carried depends mostly upon the rating of the machine with regard to the work it has to do. The more liberally rated is the converter, the greater is the range of regulation attained; if the amount of over-compounding required is large (say 15—25 per cent.), the rotary must be chosen large for the work it has to do, although not in this proportion.

Compound wound rotary converters are connected and paralleled on the direct current sides in precisely the same manner as similar direct current machines, equalising bus bars and switches being used, and therefore the same precautions have to be taken with them should accumulators be used in parallel with the low pressure feeders.

From what has been said above, it will readily be seen that of the two good methods put forward for regulating the pressure on the direct current sides of the machines, that best adapted for the requirements of lighting work is given by the employment of induction regulators, allowing the pressure to be gradually varied by hand in accordance with the slowly varying load; for traction work, the employment of compound windings (that is, regulation by lagging and leading currents) is preferable on account of the large range of regulation required, and the rapid variations of the load. In some special cases, however, the combination of the two methods will give very good results.

Rotary converters are invariably self-exciting from their direct current sides. Wherever possible then, such machines should be started from the direct current side, either from the bus bars, or from an auxiliary asynchronous motor-generator. This indirect method of starting is far preferable to any other, if no direct current is available at the switchboard.

The next best method is that given by induction motors directly coupled to the shafts of the rotaries, while the fourth and last method available simply consists in switching the machine directly on the high pressure lines. As this method has been put forward in connection with several important British schemes, and is in use in more than one of them at the present time, it may not be out of place to devote a few words to its consideration, although in general the method is objectionable.

Any modern synchronous polyphase motor can be started up without difficulty from the high pressure lines, no matter how constructed. This method of starting, as used in connection with rotary converter plants, is as follows:—The direct current main and field-switches are opened, only a voltmeter being left across the direct current side, and then the line current is switched on the slip rings, either at full or reduced pressure, this latter being arranged for by an alteration in the number of secondary turns on the step-down transformers. Owing partly to the eddy currents in the pole-pieces, metal cheeks of field-bobbins, damping coils (where these are used), but principally to the hysteresis lag in the pole-pieces, the rotary immediately starts, and is very soon up to synchronous speed. The voltmeter on the direct current side indicates nothing at the moment of starting beyond very feeble oscillations of the pointer, for the current traversing its coils is of course alternating; but as the rotary increases its speed the pointer begins to move backwards and forwards over the scale, its movements corresponding to the rapidly diminishing frequency of the pressure at the direct current terminals; when synchronous speed has been reached the voltmeter pointer will again be steady, for the current through it is now a direct current. The proper time for putting on the field current is indicated by the voltmeter; just below synchronous speed, when the pointer is moving slowly from side to side over the scale, the field current can be put on. But it makes all the difference at which side of the scale the pointer is when the field circuit is closed. If the fields have been put on when the pointer is at the wrong side of the scale, the polarity of the direct current side of the converter will be reversed; with most machines this means that the rotary must be switched out and synchronised again in order to get synchronism at the right pole. In order to make quite sure that the machine has synchronised at the right pole, it is good practice to provide a pole indicator on each direct current panel, so that the polarity of the direct current side can be checked before the rotary is connected to the direct current bus bars. Needless to say, a lamp can be substituted for the voltmeter mentioned above across the direct current terminals—it will be bright at the first moments of starting, and also when the neighbourhood of synchronous speed is reached, while between these limits the light will pulsate, and the excitation should be put on when the light is pulsating slowly, the lamp being either bright or dark, according to circumstances.

The above remarks regarding the polarity are only applicable to self-exciting machines; if the machines are bus excited, which is very seldom the case, the converter will pull itself round under protest to the correct polarity with a great rush of current, no matter at which pole the machine has synchronised. Even without the exciting current the rotary will come up to absolute synchronous speed, for there is no induction motor action with the rotary converter or synchronous motor. A rotary converter can operate without field excitation, by reason of the heavy lagging currents that would run through its armature windings under these circumstances; these wattless currents magnetise the fields to the extent necessary to produce the balancing back E.M.F. of the armature. However, such a method of operation cannot be commercial, for the machines would not carry their rated load; the heavy lagging currents would overload the mains and destroy the pressure regulation of both sides of the system, and the rotaries would spark and hunt.

When starting a converter in the manner above described, until synchronism is attained, the series field windings must be open as well as the shunt, and the latter windings must be opened in five or six places. Otherwise they would break down, due to the large E.M.F. (many thousand volts) induced in them by the alternating flux of the armature. Also, as the starting current will never be less than twice the full-load current, even if damping coils are used, and will frequently be of the order of three or four times the full-load current, it is necessary to make arrangements for short-circuiting the amperemeters and fuses, otherwise they would be damaged by the overload.

The great objections to the above described method of starting are the large starting current required, and the risk of getting the wrong polarity; the former will wholly upset the pressure regulation of the system, partly on account of its magnitude, but principally because of its low power factor, while the latter might cause an accident, and in any case would cause time to be lost when adding a machine to the circuit. For lighting work the employment of this method is absolutely out of the question.

II.—Some Features of Working.

In asynchronous motor-generator sub-stations the sets must be run as fully loaded as possible, and the motor air-gaps must be watched. As the power factor of the motors will be less than 90 per cent. below three-quarter load, running the machines well loaded becomes of great importance. It is a good thing to overload such motor-generators (in moderation) before adding a machine to the bus bars, for then a higher power factor over a wide range of load is assured. The other point just mentioned—relative to the air-gaps—is of some importance, on account of the small clearance in the motors. As the air-gap length is made as small as possible in order to get high power factors, it becomes necessary from time to time to make sure that the gap at the bottom has not decreased to a dangerous extent. With large induction motors the gap (iron to iron) will be originally about $\frac{1}{100}$ of the rotor diameter—a 200-B.H.P. motor would thus have a clearance of 0·1 in. with a rotor diameter of 3¼ ft., so that no considerable diminution of this length can be allowed on account of the magnetic pull, even assuming exceptionally stiff shafts. The stator case of such motors should never be cast with the bedplate, for if it is separate, a thickness or two of metal foil can be inserted between the feet of the case and the bedplate seatings, by removing which the gap at the bottom can be increased when the brasses have worn to such an extent that something must be done, and yet not enough to justify their replacement altogether.

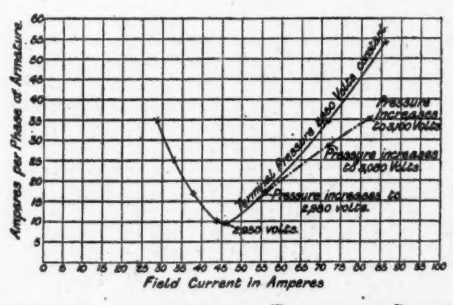

Amperes per Phase of Armature.
Field Current in Amperes
Pressure increases to 3,400 Volts.
Pressure increases to 3,000 Volts.
Pressure increases to 2,800 Volts.
2,650 Volts.

Fig. 4.—"V" Curves for 650-B.H.P. Three-phase Synchronous Motor. Constant Speed. No Load.

With sub-stations employing synchronous machinery, several important features of working present themselves. The first is the regulation of the power factor. The curves shown in fig. 4 are taken for the purpose of this paper from a 650-H.P. Kolben three-phase motor, of which an illustration follows.

* With a rotary converter of standard design, the change of field flux necessary in order to get the desired amount of over-compounding is much greater than is required with the equivalent direct current machine, for the direct current pressure is not proportional to the field flux but to the impressed pressure on the slip rings.

The shape of the no-load "V" curve of a synchronous machine is an indication of its performance—a very broad curve indicates, for instance, a motor of moderate overload capacity, and one that will require but small alterations in the excitation for varying loads; while a very steep curve indicates a machine that must work always with its excitation properly adjusted, otherwise its overload capacity will be small, and its parallel running properties inferior; at the same time, this latter type of curve is a characteristic of machines with close pressure regulation.

(To be continued).

ELECTRICAL MINING PLANT IN AUSTRALIA.

(*Concluded from page 566.*)

"*The Boilers.*—Six Babcock & Wilcox 300-H.P. water-tube boilers are erected. The feed water is supplied to these boilers by two large Worthington duplex pumps. Although the plant is a condensing one, there will be some loss which requires making up. Two of Caird & Rayner's patent evaporators are fixed in the boiler house arranged to work double and single effect, and having a capacity of 3,500 lbs. per hour when working double, and 4,250 lbs. per hour when working single. The main steam pipes are wrought-steel, 13 in. diameter internally. A rather ingenious expansion joint is connected to the main steam pipes. It has an internal balance piston, and is possibly the first of its kind in Australia. The steam pipes are fitted with Stratton water separators and Geipel steam traps. For the third unit, the main header is 14 in. external diameter steel piping, having ring-flanged ends instead of bossed flanges, and the steam pipe leading to this is 8 in. diameter outside, with ring flanges. The joints are made with corrugated copper gaskets. The **T**'s and elbows are made of cast-steel, and provision for expansion in the 14-in. header is made by a **U** bend connected by cast-steel elbows. All the valves and steam pipes were tested before erection to 350 lbs. per square inch. The boiler feed water is heated by a 1,200-H.P. Goubert heater, which weighs 4 tons. The chimney stack is hexagonal, 135 ft. high, and 8 ft. 3 in. internally at the flue level. The circulating water reservoir, when filled to the top of the embankment, will hold about 2,000,000 gallons, and will be supplied from the mines by a wrought-iron flume. There is a cast-iron sump tank in one corner of the reservoir, 12 ft. high and 11 ft. diameter, built in three rings of eight segments each, bolted together. From this tank the circulating pumps obtain their water through 16-in. diameter wrought-iron spirally welded pipes, which connect to the suction tank. From this tank 12-in. pipes branch off to the circulating pumps in the condenser chambers.

"The electrical equipment includes a generating station for developing three-phase alternating current, four transmission lines, and four sub-stations equipped with motors. The alternating current generators, direct coupled to the engines, develop electrical energy, which is transmitted by the lines to the transformers in the sub-stations. Here the current at reduced voltage drives induction motors directly connected to pumps, hoists, &c.

"The electric generators, exciters, switchboards, transformers and motors are all by the General Electric Company, Schenectady, U.S.A. The total capacity of the machinery aggregates over 3,000 H.P. The alternating current apparatus in the generating stations includes three 400-KW. machines, and two 30-KW. exciters. The large generators are of the revolving field type; they have 48 poles, run at a speed of 150 revolutions per minute, and generate a three-phase 60-cycle current at a pressure of 6,600 volts. The generators furnished for the Deep Leads Electric Transmission Company's plant are designed for high efficiency at full and partial load, close regulation, and low temperature. The frame is of cast-iron of a strong box section, into which are dovetailed the iron punchings of the core. The ventilating space between the armature laminations provides for a circulation of air when the machine is running. The windings are set in slots and held in place by wedges driven over them. The stationary armature is mounted on the engine bedplate, and may be moved to one side, clear of the revolving field. The field winding is thus exposed, and by removing the shields at either side of the armature frame, the armature windings and connections are exposed for inspection or repair.

"The field structure consists of laminated pole-pieces mounted on a cast-steel ring, and carried by a cast-iron spider. The pole-pieces are built up of sheet-iron, spreading at the pole face so as to cover a wide polar arc, and hold the field windings in place. The field coils consist of a single slip of flat copper wound on edge, so that a surface of every turn is exposed to the air for cooling. As the flat sides rest against each other, the entire coil is a structure of great solidity. The revolving field structure acts like the fan inside a centrifugal blower, forcing the air outwards through the openings between the armature laminations.

"The exciters are small four-pole generators, which operate at 675 revolutions per minute; the capacity of each machine is 30 KW., and the current is delivered to the generator at 125 volts. The exciters are belted to pulleys on the armature shafts of the alternators.

"The switchboard in the generating station consists of nine marble panels, the whole of which are fitted with a full equipment of the latest types of electrical instruments and appliances for controlling the generators and indicating the station output. On each feeder panel and on the totalising panel are mounted Thomson integrating wattmeters, by which the output of the station is recorded. Oil break switches are used; in this type of switch the interruption of the circuit is effected under a special insulating oil, which entirely prevents the flashes and arcs common on the ordinary type of switch.

"The machinery is protected from lightning discharges on the aerial lines by efficient arresters. A static ground detector is used to detect grounded circuits. Special fuse boxes are placed in each feeder and generator circuit; in these boxes when a fuse blows the terminals are immediately drawn apart and the arc is extinguished.

"At each mine is located a sub-station containing transformers for reducing the 6,000-volt line current to 440 volts for motor use.

"Induction motors will be used for operating the hoists, puddling pans, pumps, and stamping machinery, &c., at the different mines. At the New Havillah, Charlotte Plains, and Junction Deep Lead Mines 250-H.P. motors are used. These motors are constructed to run under water if necessary, and are installed with the pumps in the pump chambers at the bottom of shafts 350 ft. underground. At the Victorian Deep Leads Mine the Cornish lift pump will be driven by a 400-H.P. motor installed in the engine house on the surface. Electric light will be used throughout all the mines.

"The transmission lines are from 1½ to 5 miles in length to distributing stations, and are constructed according to the latest and most approved methods. Porcelain insulators of high insulating properties are used.

"The entire plant is of the most modern type, combining all the latest American and European improvements. The effect of such enterprises will be powerful, and widely felt throughout Australia. By decreasing the cost of mining and treating material, mines which now pay will pay better, whilst many properties which, on account of low grade stuff, or remoteness from railroads and fuel supply, cannot now be worked without a loss, can be made, by means of electric power, to yield satisfactory results. The effect will be to open up large areas of deep lead and low grade quartz reefs which have lain neglected. By this electric power development Victoria has reached a new era in its destiny, for the excellent work done by the missionary installation is sure to exert a beneficial reflex influence on the colony, and to bring about a change to newer methods in mining which are most sadly needed."

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

NOTES ON SOME SYSTEMS OF LAYING UNDERGROUND CABLES.

By Arthur Devey.

(*Abstract of Paper read March 13th*, 1901.)

The usual systems of laying may be divided into headings as follows:—1st, laying cables direct in the ground, armoured or unarmoured; 2nd, pipe or conduit systems; 3rd, solid systems.

The first system is much in favour where first cost is a consideration. It is usual to lay armoured cable; however, the town of Bray is one case where plain lead-covered cable has been used with satisfactory results, the cables being laid in puddled clay, and covered with boards 7 in. wide by 1 in. thick. These cables were originally braided, but it was found that the braiding soon rotted and was therefore useless; although they are some of the oldest, if not the oldest paper cables in the kingdom, they are still in perfectly good condition. Leith is another example; here, however, the cables are laid in sand and covered with steel plates.

It is hardly necessary to say that the ordinary British navvy is no respector of anything he comes across in his excavating work. It is, therefore, usual to cover the cables with timber to indicate their presence, and so prevent mischief from this cause. The cable joints on direct laid systems, if boxes, do not require any special protection, but the armour should be taken into the glands, and the iron of the box should be bonded to the armour of the cable; but if wiped lead sleeves are employed they should be protected with wood troughs filled up solid with bitumen, or preferably by cast-iron troughs and covers which can be bonded to the armour of the cables on each side, thus ensuring a continuous metallic covering from end to end, and so protecting the lead from stray currents. Laying direct in the ground has the advantage of being a very flexible system, and the work can be carried out whatever the weather may be. Its disadvantage is that the outer layer of jute sooner or later rots off, exposing the iron or steel armour, which in turn gets eaten away; of course the quickness or slowness of these actions depends on the nature of the soils in which the cable is laid.

Turning to pipe or conduit systems, their advantages lie in the fact that cables can be drawn out in case of need and new ones drawn in, without disturbing the surface of the streets; also that spare ways can be laid for future extensions. Their disadvantages are, however, numerous. They are not flexible, and unless the pipes or conduits are laid practically straight and level, it is exceedingly difficult to get the cables in, and still more difficult to get them out again when necessary; of course, if a cable cannot be got out easily in case of need, then the only real advantage of a pipe or conduit system is reduced to its spare ways, and if these have not been laid in sufficient numbers then the whole system goes to pieces. Another serious disadvantage lies in the

fact that if a fault occurs on the cable, it is necessary to draw out the whole of the faulty length and to draw in a new length, which means keeping a large stock of cable on hand to be able to meet any demand. There is also the making of two joints, whereas on the other systems it is simply necessary to open out the ground at the place where the fault has occurred and have the fault made good, which can very often be done without putting any new cable in at all. There is no doubt that a fault on a pipe system certainly costs very much more to repair both in time and money, than one on the other systems, and if the faulty cable should be, say, one of the centre ones in a nest of 15 or 20 pipes or conduits, then the work of repair is exceedingly onerous, and may require several days to carry out, or even be impossible if the cables are jointed straight through the box. Yet another disadvantage is that it is practically impossible to keep a pipe or conduit system dry, while a still greater one is the risk of explosions from gas leaking into the pipes or boxes. These sometimes occur with disastrous results, and are liable to happen notwithstanding all precautions to the contrary. In any case it is advisable that all box lids should be ventilating, and in important streets it would pay to have air blown through the pipes or conduits at stated periods. Strict injunctions should be issued that before any work is done in a box, the workmen must make sure that there is no gas present. A very good plan is to open the boxes on each side of the one where the work is to be carried out, allowing the air to circulate for say 10 minutes; but even after that has been done, it must not be taken for granted that all the gas has gone.

Boxes, if large, are nearly always built of brick, with concrete bottoms. These should be at least 6 in. thick, and the walls should be 9 in. brickwork up to 6 ft. square, and 14 in. brickwork for 6 ft. square or over. They should always be connected with the sewer through a trap. A notable exception is the large 6-foot box of the G.C. Electric Light Department, which is a solid C.I. chamber, guaranteed gas and water tight. They must be expensive, but are no doubt well worth the outlay.

Small boxes are either of bricks or iron, and very often the bottoms are just the plain earth; the idea being that the water can drain away through it. These boxes should have ventilating but water-tight lids.

The lids should never be less than 2 ft. square for pavement boxes; for road boxes they should be preferably circular 2 ft. in diameter, and the frames should be at the very least 15 in. deep. If the frames are not deep enough, then it is practically impossible to get a proper covering of concrete on the top of the box, as there must be an inch or two of sand for the bedding of the setts, and these latter are usually about 7 in. in depth. The natural consequence, of course, of not having the roof of the box sufficiently concreted is that water is continually leaking through the roof. In any case the sets over the roof of any street box should always be thoroughly laid in pitch.

Manholes should be roomy, and cables should be taken round the sides attached to proper supports, and not jointed straight through the centre of the manhole; if so done, they are liable to be easily damaged by men using them as ladders, and also the joints are exceedingly difficult to get at. They can never be made too large, but very often are made too small. All covers should be locked, to prevent unauthorised people from getting into them and damaging the cables; the pipes should always be bonded to each other across all brick boxes as a protection to the cables against electrolysis, and all iron lids and frames should be well earthed.

The diameter of any way should exceed that of the cable by a clear ½ in., and by preference more if possible, and it is not advisable to have longer runs than 150 yards as a maximum. The number of boxes in consequence is very considerable, and in large towns and busy streets it is extremely difficult at times to find room for them or even for the pipes; especially when the gas and water people demand at least 18 in. clearance all round their pipes. In consequence, where there are numerous ways, it is very often necessary to fan out the ways of one layer into those of the next layer, which naturally does not improve the drawing-in of the cable. As regards the water mains, this is not such an out-of-the-way demand as they will always be with us; but as regards the gas mains it is a different question, as we all hope they will disappear by degrees, although possibly they might be utilised by their enemy. Such apparently has been the case already, as it is said that electric light mains have been surreptitiously drawn into gas mains in a certain Scottish town without, of course, the gas engineer's knowledge or consent.

Whatever pipe or conduit system is adopted, it is absolutely essential that it should fulfil the following conditions:—It must have a perfectly smooth interior, free from all lumps or projections; the joints should be watertight, and so arranged that the jointing material cannot get into the interior of the pipes or conduits. The various units of it should be as long as possible so as to minimise the number of joints, and these units should be capable of being easily cut into short lengths, so as to get round bends or obstacles. The system should always be laid so that there is a fall from one manhole to the next, so that all water may drain away easily.

Some of the pipe or conduit systems are as follows:—(1) cast-iron pipes; (2) sheet-iron pipes lined with cement; (3) pot pipes; (4) Doulton's conduits; (5) cement blocks; (6) earthenware octagonal ducts; (7) wire and cement ducts; (8) pump log ducts; Brooks's semi-solid system.

Cast-iron pipes have been much used in the past, and still are in fashion to a certain extent; their advantages being fairly good mechanical protection to the cables, although, of course, they will not stand a wedge. They require careful caulking, as if by accident or on purpose lead is allowed to run into the interior of the pipe, it is exceedingly troublesome and expensive to get it out Sometimes, however, turned and bored joints are used, as also red lead and yarn joints; but lead joints are the usual and best ones.

When cast-iron pipes are used they should be carefully inspected before being laid, so as to make sure that they are of the full specified bore, perfectly smooth and clear inside the edges, and rounded off at each end. As to electrical protection of any lead-covered cable that may be drawn into them, opinions differ very greatly. Some experts say they are a guarantee against electrolysis, whilst others affirm the contrary. There is certainly no doubt that the lead joints of C.I. pipes are of a very much greater resistance than the pipe itself. Then again some experts say that the lead covering of the cable should be metallically continuous throughout its entire length, other equally expert experts maintain that the lead should be broken every 150 yard or so. Moreover, the questions whether to use earth plates or whether to connect the lead sheathing of the cables or the pipes to the iron rails or to the negative bus bar of the power station, are all still debateable *ad infinitum*.

Rivetted sheet-iron pipes lined with cement have been used considerably in the States and in this country lately, for tramway work chiefly. They are 8 ft. long by 3 in. bore, the thickness of cement lining being about ⅛ in.; these have to be surrounded on all sides by concrete, they will not, of course, stand any serious knocking about, as the sheet-iron is so thin and is surrounded by concrete. If laid near the surface, navvies are very liable to put a wedge or a pick through them and into the cable, as they think the concrete surrounding them to be the ordinary concrete of the street; they, therefore, should never be laid at less than 2 ft. 6 in. from the surface of the road, and should always have a layer of loose earth on top of the concrete.

No bends are made with these pipes, the consequence being that boxes have to be built at every right angle corner or sharp bend.

Doulton's conduits, which are used so extensively throughout the country, are so well known that they do not require describing. Care must be taken in making the joints to prevent the bitumen or cement running into the inside of the conduits, and so blocking them up more or less. With cement joints, stoneware bearers and wood mandrels are used; with bituminous joints, cast-iron bearers and expanding india-rubber mandrels are required. These conduits are made with square ways from 1½ in. square up to 4 in. square, and usually 3 ft. long.

An advantage in using them is that a large number of ways can be got into a small trench.

Conduits are also made, from 3-ways upwards, in cement blocks; they are very easily broken when lying on the trench side, and require very careful laying. They are said to be expensive for a small number of ways, but economical when there are many ways to be provided. It is stated that the hardened cement has no deleterious action on the lead of the cable and that the blocks harden and improve with age. As the ways, which are round and 3 in. diameter by 1 metre long, must be exactly opposite each other at every joint, iron rods along the sides are used to obtain this result, mandrels being placed in the ways whilst the joints are made with cement; the iron rods are also supposed to keep the ducts in position should the ground sink after the laying of the conduits.

(To be continued.)

UNDERGROUND ELECTRIC RAILWAYS.

Action of the London County Council.

The question of underground electric railways was discussed at last week's meeting of the London County Council, when the following notice of motion was submitted for consideration:—

That it be an instruction to the Highways Committee to consider (*a*) the routes along which extensions of the London tramways system ought to be taken, having regard to the needs of the inhabitants in every part of the county; (*b*) the establishment of a tramway centre or centres to which extensions shall converge; (*c*) the railway extensions required to perfect the London overhead railway system; (*d*) the extensions required to perfect the London tube or underground railway system; and to report to the Council their conclusions at the earliest possible date.

Dr. G. J. Cooper, who proposed the motion, stated that one of the reasons he had placed it upon the paper was because of the large number of tube railway promotions brought before London within the last year. He thought the Council should have a definite and distinct policy in dealing with the tube railways, and directly they touched that particular subject they were compelled to recognise and take into consideration all means of communication in London. It would be a wise thing to instruct the Committee to consider the whole question of communications, in addition to tramways, railways and underground lines, and bring up some suggestions as to how the Council should proceed in the future. He would like to know whether the construction of the tube railway under Oxford Street to Shepherd's Bush precluded the Council from building a tramway on the surface along the same route. He was not at all certain that Parliament would not say that the Council could not enter into competition with the railway company without paying compensation. Parliament had just given the Metropolitan Railway Company a *locus standi* in regard to the Council's River Steamers Bill, and Mr. Hills, of the Steamboat Company, was pushing forward for compensation

for his steamboats. It was, therefore, quite possible that Parliament might give the Central London Railway Company a *locus standi* against any tramway laid along Oxford Street and Edgware Road, and might also require the Council to give the company compensation. That would mean that the Council would have to give the shareholders compensation, and the Council would have to stand by and be the loser. There were 14 tube promotions this year, and they all seemed to have been drawn from nowhere to nowhere. The Council ought not to let the opportunity slip for doing something towards a central organisation, and the Committee should settle the lines in the interests of the people of London. It would be possible for them to say to the companies that if they proposed lines which were against the interests of London, the Council would actively oppose them. The adoption of the motion might lead the Committee to a useful decision, and be of great benefit to the whole of London in arranging the method of railway communication.

Mr. Sidney Low, who seconded the motion, remarked that at the last meeting of the Highways Committee the question as to the powers possessed by the Council in regard to tube railways was brought forward at his instance, and the subject was now being investigated. The confusion in which the whole question was involved had in no degree been exaggerated. The underground railways had been planned and brought before Parliament while the County Council were looking the other way. If the Council had realised, a few years ago, the great importance which the underground railways were likely to assume in the future locomotion of London, the Council would have formulated a definite policy on the subject. There were 15 rival and competing lines with a capital of £30,000,000, and forming their plans without co-operation with one another. The question would not admit of delay, as in the present or next session nearly all the schemes would come up for consideration, and the chances were that in the next few months or so, if no definite action was taken by the Council, they would discover that the available underground locality would be intersected by a network of those railways. If the schemes now before Parliament were carried, they would find that a large number of the tramway plans projected by the Council for the promotion of traffic would be interfered with or rendered superfluous. A joint committee of both Houses of Parliament had been appointed to consider the whole subject of underground electric railways, and he ventured to suggest a rider to the motion to the effect that the Highways Committee should be authorised to take steps to secure the views of the County Council being placed before the joint committee.

Mr. J. Stuart, in supporting the motion, observed that if the Council had proposed such a step five or six years ago it would have been gibbetted all over London for interfering with the question.

After some observations from Messrs. R. Parker and H. Williams, the motion was agreed to, with the addition suggested by Mr. Low.

THE GENERATION AND TRANSMISSION OF ELECTRIC ENERGY AT AND FROM COAL PIT CENTRES.

By B. H. THWAITE, C.E.

(*Continued from page* 505.)

The Importance of Control of Fuel Costs.

In an introduction to the catalogue and guide of the Gas and Allied Trades Exhibition recently held in Manchester, the acquirement of coalfield areas to satisfy the gas-making requirements was suggested by the author as most advisable, and the principle has been accepted as a financially sound one.

If the Electric Power Supply Companies adopt this principle, in their financial schemes, it will immensely strengthen their position, and at one stroke they will remove one of the most formidable objections raised against the author's original project.

This objection was, that steam or other power users would seriously hesitate before discarding their own independent existing power supply, in favour of a public one that *might break down*, because the cost of coal made it impossible for the company to supply the power within the price limit fixed by Parliament.

In a scheme drafted out two years ago by the author for the generation of power for a large German city, the intention was to erect a high class and altogether modern coking plant with a bye-product recovery equipment, the coke to be specially broken for household and manufacturing purposes, the inferior coke being used, along with a certain proportion of the effluent gases from the coke ovens, for power development purposes. Only by such a scheme can a gas of suitable calorific character be obtained for the purpose of driving large power gas engines, coupled to three-phase alternating generators.

To adequately satisfy the fuel requirements for large power generating stations, the ownership of the coal-bearing strata and workings is certainly an essential to continued success.

Independence of Fluctuations in the Value of Coal.

Any well-arranged project of power production from a waterfall, includes the purchase of the water rights, and no fluctuations in the cost of dynamic energy are likely to disturb the charge limit to the consumers.

Therefore the author reiterates, that any well-conceived project of electric power supply in bulk, should include in its commercial scope, the absolute ownership of a coal-bearing area, sufficient to satisfy the requirements of the power generating station for at least 50 years.

The importance of this commercial qualification, almost deserving the rigid definition of a financial axiom, will be understood, if the fluctuations in the price of coal during the last few years are properly realised. Such a serious increase in cost of fuel has ruined many British industries, and an equivalent inflation in the price of coal to an electric power supply (in bulk) company, rigidly limited to a maximum charge for electric energy by Act of Parliament, might mean complete ruin.

But if such an electrical power supply company entered into the absolute ownership of the coal-bearing strata to supply its generators, it could introduce electrical coal-cutting and getting machinery and utilise mechanical and automatic resources to the utmost degree, and the company might further increase its appliances for getting coal so that full advantage might be taken of the rise in the price of coal.

The acquirement of the coal area might permit the electric power supply company to erect coke ovens together with an adequate by-product recovery plant, so that the ideal power gas generating station could be constructed that would provide the utmost possible profit-making possibilities.

The author explained in the original arguments supporting his first project of 1892, that with the present railway rates and the middlemen's profits electric transmission is the most economic, even with the price of coal at the lowest point in recent years. Of course, if our railway companies introduced electrically propelled large (50-ton capacity bogie hopper) coal cars or wagons, they would be able to reduce the railway rates to the level of those in Germany, and the economy of electrical power distribution would then not be so great; but there are so many advantages to be gained by the employment for power transmission, of the electrical agent, that even at the same cost for power, it would still be the unquestionable favourite with all power consumers. Besides, the sale of electrical power in bulk will enormously stimulate the establishment of industries depending upon electrical phenomena as their *raison d'être*.

Scale of Charges for Supply of Electrical Energy in Bulk.

Numerous proposals have been formulated for defining the rates to be charged for the supply of electrical power.

The Tyneside scheme promoters proposed the following:—Motive power for manufacturing purposes: first 100 hours, 3d. per B.T.U.; subsequent hours, 0·9d. per B.T.U.

The Brighton scale of charges is popular:—Electrical power in bulk, not less than 400 hours, 4d. per B.T.U. Beyond this the charge to be reduced to 1½d., and even as low as 1d. per B.T.U.

In the Power Bills it is generally agreed that when 10 per cent. has been paid upon the subscribed capital, the sliding scale proportions shall be reduced.

The Midland Supply Company (Staffordshire) contract to supply energy for 1d. per B.T.U.

Example of German Charges for Light and Power.

The author gives the following particulars of a modern German installation (carried out by the Allgemeinen Elektricitäts Gesellschaft) as a typical example of a three-phase trunk distribution (transformed for customers' requirements) in the industrial area in Oberschlesischen.

The energy is transmitted from the central station, at a line pressure of 6,000 volts, to sub-stations, where it is transformed down to 120 volts for distribution to the consumers.

The steam-power capacity of the central station is equal to 7,060 KW. output.

Up to the middle of last year, the power drawn upon by the consumers equalled that required to supply 31,519 incandescent lamps, 727 arc lamps, and 149 motors, involving an absorption of 2,996·8 KW.

The 149 motors are devoted to the following applications :—

Number.	Service.	E.H.P.
13	Printing machines	28·5
18	Smiths' shops	81·5
39	Ventilators and fans	270
8	Meat and sausage machines ...	19
1	Crane	10
5	Coffee roaster	7
20	Metal working machinery	224
6	Carpenters and joiners	16
3	Haulage machinery	90
4	Pumps	3
1	Serving machine	1
3	Agricultural machinery	15
4	File cutting machines	24·5
1	Ice machine	5
3	Brewing machines	17·5
5	Lifts	30·5
4	Mechanical workshops	15
9	Power transmissions	77·5

In addition, some 1,400 KW. of power has been asked for up to the end of last year.

The inhabitants of this industrial centre appreciate the advantages of electrical transmission, and especially the low charges which are made for it.

The only motors used are of the three-phasic type. The experience of the users in this district is that :—

1. They are very convenient.
2. Easy to instal.
3. Light in proportion to output.
4. Require little attention beyond the trouble of starting and stopping, and lubricating.

The motors are economical in action, the power consumed being nearly proportionate to that required, and varying according to the consumer's demand.

The low first cost of the three-phasic motors puts them within the financial power of small manufacturers or owners of small workshops.

They are readily applied directly to every kind of machine or tool, thus avoiding the necessity of belt transmission gearing, a feature proved to be so wasteful, besides involving so much head room and space.

System of Charging for Energy.

Electric Light.—For the first 400 hours, 50 pf. is charged per KW.-hour; all energy consumed in excess of this period is charged for at the rate of 2 pf.

Deposit for Equipment.—A charge of 1 mark is made for each incandescent lamp, and 5 marks for each arc light; and for heating and cooking, 5 marks are charged per KW. of input of the stoves. The following are the annual rates charged for hire of meters up to :—

25	16-C.P. lamps or their current equivalent,		13·5	marks.
50	"	"	18	"
100	"	"	27	"
200	"	"	36	"
300	"	"	45	"
400	"	"	54	"
600	"	"	72	"
1,000	"	"	90	"

As an example of the working of the above tariff, a tradesman has an electric equipment in his shop made up of lamps incandescent for 1,400 hours per year.

The average price will be 15·7 pf. per KW.-hour. One lamp-hour will cost 0·8d pf. When the 1,400 hours is exceeded, the cost per lamp-hour in excess is 0·1 pf.

A Power Example.—A 10-H.P. three-phase motor is actuated for 10 hours a day for 300 days per year.

The average price per KW.-hour equals 8·4 pf. The cost per H.P.-hour equals 7·27 pf. Assuming that the electric motor runs for 24 hours per day throughout the entire year (say for pumping and ventilating purposes) the average cost per KW.-hour = 4·16 pf., or per H.P.-hour = 3·6 pf.

The Electric Supply Company is indifferent whether the customer has one lamp and motor, or 100 lamps and motors, he has the benefit of the reduced charge for energy immediately he has consumed energy for 100 hours.

Owing to the high efficiency of the three-phasic generating and transmission machinery, the Electric Company is able to offer energy at the very low rates specified, and all the power consumers in the ind ustrial centre will soon be connected to the service mains.

Progress in Power Generation and Distribution.

Since 1892 the following innovations have been introduced :—

In the Economic Production of Power.

1. The blast furnace has been harnessed to the dynamo through an internal combustion engine.
2. Coke ovens with tar and ammonia recovery plants have been seriously proposed as the means of power gas generation for internal combustion engines. The author submitted such a form of central power generation for Berlin in 1897.

In the Economic Generation and Transmission of Electric Energy.

3. The Electric Transformation.—Three-phase alternators have been utilised as the fly-wheels of large steam and gas engines.
4. The Transmission.—The line pressures have been raised to an average of 10,000 volts and to a maximum of 50,000 volts.
5. The Reduction of Electric Pressure and Phasic Reorganisation.—Rotary transformers have been developed to a high degree of efficiency.
6. The Re-Conversion into Rotary Motion.—Induction motors up to 1,000 H.P. output have been successfully introduced, and the tendency is towards higher powers.
7. The Conductor Metal. — The cost of producing aluminium has been reduced to so low a point as to make this metal a possible competitor, for line transmission work, with copper.
8. The Switches.—The introduction of oil switches for high pressure work has proved successful.
9. The Widening of the Field of Electric Application.—The extended application of electric energy for industrial purposes has taken place in most unexpected directions.

(To be continued.)

THE TESTING OF ELECTRICAL PLANT.

We have been particularly impressed with the enormous waste of fuel that is made compulsory upon the makers of electrical plant when testing dynamos against a water or other useless form of resistance. It appears to us that this waste is entirely unnecessary, that the results sought by the tests that make for this waste can be practically obtained by other means; and, moreover, that some of the tests enforced are positively misleading and mischievous. Of course, the idea at the bottom of the use of artificial resistance is the obtaining of a load on which the dynamo may expend its energy in the absence of a proper natural or productive load. This might have been necessary in the early days of the electrical industry, when installations were few and far between, but to-day surely there are sufficient examples of lighting and power installations to place most manufacturers in the position of being able to use a productive load.

Coming to purely engineering objections, there is, of course, the argument that if set to feed a traction or power system the load would be variable, and the customary specified six or eight hours' run at full load could not be complied with. Thus we find a 100-KW. set is specified to run at full load for six hours and then to run at an overload of 25 per cent. for a further two hours. After a few such tests one readily

comes to the conclusion that they are comparatively useless. They do not put upon the engine anything approaching the maximum power at which it will be called upon from time to time to work for short periods, and on the other hand, they probably subject the generator to a far more severe test as regards temperature than it can ever be called on to withstand in its regular duty. Especially, then, for traction work do we think that tests might be made on actual varying loads, the tested plant being put upon a line and made to take so large a proportion of the load as to expose it to certain maximum stresses during a day's run for example. During such a trial the engine would several times be called upon to turn against resistances such as it will be required to overcome in its actual work, and the generator also will be called on for a practical test, and will not be injured by an excessive strain, such as may be the case under existing test demands. We have before referred to the design of American traction generators. They are excellent machines, and can usually be put upon load at once without any trouble as regards windings or compounding proportions, but they are most narrowly designed as regards their margin above test loads, on which they get very hot indeed, and throw shellac freely. Yet they do not become hot when put to their regular duty, because then they have a mean load of but 20 to 40 per cent. of their rated capacity. English designers are apt to make their machines to run cool at full load throughout the test. This is one phase of American competition. Excellent as to design, there is a paucity of material in an American generator, yet no one can say that an American machine does not do its work, though it may barely scramble through its tests, and is perhaps only allowed to do so because its excellence on electrical points is so plain. Americans leave less to final adjustment at the place of work, and it would appear that English makers have made their designs as though the machines would always be run at test loads. It ought to be possible so to specify as to obtain fairer results. The maker of a dynamo simply rates his machine as he likes. The power of a steam engine is controlled by its cylinder volume and speed, and two engines can be fairly compared on these particulars, but dynamos of equal speed and rating, and of similar design, may be found that vary nearly 100 per cent. in size. Makers ought to be asked to state more particulars than they do, such as weight of copper. If this could be arranged, and tenders were made to state such facts, and tests were made on a rational basis, there would be a better chance of getting value. Of course, the limit of heating of fields and armatures would require to be considerably reduced. It would never do to allow present test temperatures to prevail on general working, and this would put some stop on the extreme economy of design that now enables an American machine to pass for larger capacities than it is entitled to do. At the same time, while conditions are what they are, shall we blame the American makers for this economy when they simply take advantage of the well-known fact that a mean load is rarely more than a third of the maximum, or in excess of half the rating?

With a practical test load on actual work all the coal now wasted would be usefully employed, and we are strongly of opinion it ought to be, especially as there are really no good reasons why such a mode of test with integrating watt-meters should not be employed with advantage all round. The present system of steady full load tests gives false ideas of steam engine economy, tends to extravagance of design on the part of both steam and electrical plant, and imposes a continuous economic loss on the plant ever after, as well as excessive charges for interest on first cost. As an example may be cited the case of a tramway system, the power plant of which passed the specified tests as regards steam consumed per KW.-hour. On the assumption that the evaporation was, say, 7 lbs. per pound of coal, the fuel consumption per unit works out at 5¼ lbs. When put to actual work, that same plant, though maintained in excellent order, used from 13 to 16 lbs. of coal per unit, the difference being due to the excessive size of the engines for their mean load, a difficulty that must always arise where compound engines are run on a small system. The steam per KW.-hour which the official test showed to be about 24 lbs., was thus proved to be actually about 63 lbs. Now had the steam consumption proved to be about 36 lbs. on the steady test load, it is possible that it would not have exceeded, say, 45 lbs. on the actual running load. These last two figures are merely to illustrate the idea, and are not based on calculation; but they are probably fairly characteristic and serve to point the argument that full load tests are useless and misleading, for they do not even give an approximate idea of the economy of a plant in practice. As a matter of experience, the term full load is one that must not be used with any fixed ideas in relation to traction plant, for which there are two critical loads—the mean load that measures the economy, and the maximum load, or load at which the engine must be able barely to turn round, and at which the automatic line cut-out ought to be nearly active if the instruments are well regulated. As regards the application of the same system of test to a lighting plant, it is far easier, in a sense, than in the case of a traction plant, for the tested engine can be simply run in parallel on the feeders from end to end of a day's cycle, and can be kept well up to its load all the time, any diminution or change being dealt with at the proper station.

Considering the amount of good coal now simply wasted, it ought to be possible for arrangements to be made somewhat on the lines indicated to put the current produced to useful purpose, and there are good grounds for believing that more satisfactory tests and more practical results could be secured by this than by the methods now prevailing, and that have been adopted, not because they are the best methods, but because there have been until lately so few systems to feed with the test current. This reason no longer stands, and tests should be modified in accordance with rational and now practicable procedure.

Prof. Short recently pointed out that traction motors were rated so that their temperature increased 75° C. after one hour's run at full load over the temperature of the surrounding atmosphere, and he added that these motors would give continuously one-third their rating without excessive heating, but the average current consumed would not as a rule amount to this proportion. If the same figures and proportions are also allowed in American generator practice, we can understand how it is that Americans can compete so well on a basis of nominal rating, for it is certain that many English generators will work for hours without experiencing any such rise of temperature as the above allowance. We are confident that for equal liberality of design, the question of American competition would be very seriously modified, and that what English makers really require to do is to take greater care to adjust their machines before sending them out instead of having them adjusted in place. This is done with the best American machines—indeed it is imperative because of distance. The home manufacturer is less careful perhaps because he is so near to the place of user, but we are afraid he makes a great mistake. Machinery of this description ought to be practically complete before erection in place.

SOME NOTES ON CHANGES OF PERIODICITY.

THE above is a subject of such importance and intricacy that any attempt to deal with it adequately in a few occasional notes must necessarily be futile. But in view of the fact that so little has been published on the subject, the following remarks and suggestions may not be out of place. The reduction of the periodicity to the lowest possible value in an installation for the supply of power and light has the following chief advantages:—

1. The reduction of the capacity current taken by the mains at light load in direct proportion.

2. The reduction of the speed of motors without increasing the number of poles.

3. Improvement in the parallel running of alternators, and greater ease in synchronising.

4. The "skin effect" in cables will be reduced. But this will probably not allow of any material increase in their size.

The first of these advantages is probably the most important, and when very high voltages are used, and the cables have much capacity, may alone justify the reduction of the periodicity to the utmost limits. This limit seems to be reached at about 50 periods in installations whose chief object is the supply of light, the reason being that this periodicity is about the lowest that will give good incandescent and arc lighting; anything lower than this is detected on the lights.

The following remarks apply to a change from 100 periods to 50 periods, which is probably an extreme case; but with changes of a lesser degree, most of the statements will still apply in a less marked manner.

Generation.—In conducting a change of periodicity, it will be necessary to run two sets of machines at the same time for a considerable period, it being impossible to change over the whole plant to the new periodicity in a single day, or even in a single month. This means that the station cannot be run economically, as during the long periods of light load two sets of plant must be maintained at full speed instead of one, and probably also two sets of spare plant must be kept moving, or, at any rate, ready for instant use. This will involve increased work for the station staff, which will probably require increasing, as with the exception of the boilers, practically two stations have to be run.

This uneconomical state of affairs may be to a great extent minimised by using motor-generators to supply one periodicity off the other at light loads. Such motor-generators would consist of two alternators coupled together on the same shaft, to which is also connected a direct-current generator; this last would be used to excite the alternators, and also to run them up to synchronism. The use of such a complicated arrangement, however, requires great care, if large units are used, and the motor-generator is of small capacity. The two large units will, during the period of changing over the load, be connected rigidly together by means of the motor-generator, but unless the turning moment of the engines is very regular, there is a great tendency to get out of step. Thus the voltage becomes irregular, causing the lights to surge up and down, and preventing a proper transference of the load. The first cost of such plant would probably also be excessive for such a temporary purpose.

It is also necessary to divide the station switch gear into two sets. This is, however, usually a simple matter, if the Ferranti type of switch gear is in use, and the addition of another synchroniser presents no difficulties.

Many of the station instruments used on the old periodicity will not read accurately on the new periodicity, and these will, in most cases, require rewinding. In most alternating stations, however, the high tension voltmeters are of the electrostatic variety, and these will, of course, read equally well on the new periodicity.

Distribution.—Perhaps the most difficult part of such a change is, however, in the distribution system, and the method of procedure must, to a great extent, depend on the arrangement of that system.

The most convenient method is to change over all the area supplied by one high tension feeder at one time. To do this it will be necessary to consider the apparatus which may be connected with the network, and to make provision for its rapid change to an apparatus suitable for working on the new periodicity. Such apparatus includes arc lamps, motors, meters, transformers, and measuring instruments. We will take these in order:—

Arc lamps will perhaps give the most trouble, owing chiefly to their number. It will be found that in a change from 100 periods to 50 periods a large number of the arcs in use must be entirely replaced by lamps designed for the new periodicity. In many cases, however, the makers of the lamps will guarantee to adapt them to the new periodicity by the use of new choking coils and alteration of adjustments. Many of the modern "enclosed" arcs can, moreover, be readily adjusted to the new periodicity.

Motors will probably be few in number, but as their speed on the new periodicity will be halved, even should they continue to run without burning out, provision must be made for changing each one on the circuit.

Meters are a most important item, and if unsuitable for the new periodicity, will involve great expense.

Fortunately there are several types of meter which will render an accurate record on almost any periodicity, and it is the almost universal practice to use one of these types on alternating systems. The following meters, however, will *not* give the same readings on the new periodicity, viz.:—Schallenberger, Chamberlain & Hookham, or any other types using iron in the alternating magnetic circuit. Aron meters are also likely to give trouble, as their automatic winding gear contains a shunt coil wound on a laminated iron core, which, if designed for 100 periods, will blow its fuse at 50 periods.

Transformers.—These are probably the most important apparatus in the distribution system, as if they do not work satisfactorily and with freedom from breakdowns, interruptions to supply are almost inevitable. Experience gained by a long series of tests under practical running conditions, extended over a period of 12 months, leads to the conclusion that—

Transformers designed for 100 periods will work at 50 periods, giving practically the same ratio and secondary drop, but they will take some 25 per cent. more no-load watts, and will get proportionately hotter.

After working on 50 periods for 12 months, the "no load" current will have increased to nearly 35 per cent. more, and it needs no prophet to foresee that the life of transformers so used will be very much reduced. The transformers to which we refer were by a well-known maker, and of 20-KW. capacity. They had previously been in use on 100 periods for a considerable time, and had given no trouble on that periodicity. They may, therefore, be taken to have given a fair average result.

The increased "no load" current will work out to a considerable increase in distribution losses in the course of a year, but perhaps even this is less important than the increased heating of the transformer, as this heating, besides tending very much to shorten the life of the transformer, may cause the sub-station in which the transformers are placed to become excessively hot.

These sub-stations are not infrequently very difficult to ventilate under ordinary conditions, and if mechanical ventilation is rendered necessary a considerable outlay may be incurred.

With some types of transformer there is little doubt that such an increase in temperature would destroy the insulation, and therefore, no matter what make of transformer is employed, a reduction of periodicity is likely to cause quite an epidemic of transformer breakdowns.

With regard to instruments in sub-stations, the same remarks apply as to those in the generating station.

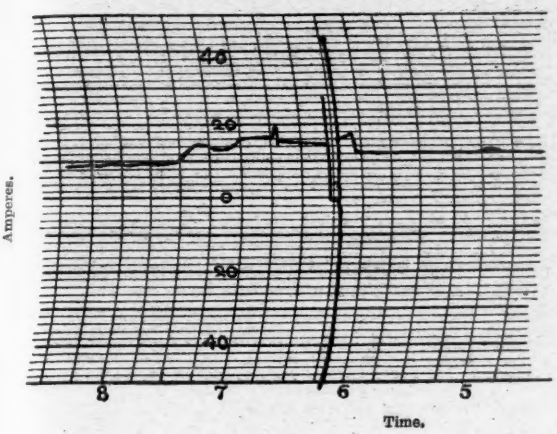
Before concluding, it is necessary to state that the change of periodicity on which these remarks are based was also accompanied by a slight change of "wave form," the 100-period generators giving practically a sine curve, whereas the 50-period generators were found to give a very slightly more peaked curve. This, no doubt, tended to increase the effects of the change on the apparatus concerned.

BARE COPPER MAINS AND BURST WATER PIPES.

An objection frequently urged against bare copper mains, even by those who admit their many points of superiority over any other class of main, is that in the event of a water pipe bursting they may be short circuited and greatly damaged. It may not be uninteresting, therefore, to give particulars of an instance in which such a mishap has occurred in Manchester.

About 6.25 a.m. on the 28th ult., a 16-in. cast-iron water main, laid in Miller Street, burst. Along the same street there runs a concrete culvert containing five $\frac{1}{4}$ square inch conductors laid on the Crompton system. Manholes about 3 ft. 6 in. × 3 ft. 6 in. × 5 ft., provided with ventilating covers, are fixed at each end of the culvert. The main was not cut off until 7.30 a.m. No effect was felt at the station, and there was very little disturbance in the earth current, as will be seen from the accompanying tracing

taken from the recording ammeter through which the connection to earth from the middle wire is made. The current rose from 12 amperes (the normal) to 17 amperes, then fell off to the extent of 2 amperes, and momentarily attained a



sufficient value to throw a circuit-breaker set for about 80 amperes; this circuit breaker was restored within about three minutes, when the earth current was found to be only 14 amperes, remaining at this value until the main was cut off.

On opening out the culvert it was found that the water from the main had rushed through it, and the lower end—the street having a considerable gradient—was actually filled up with soil carried in by the water.

On inquiry it was found that the water which entered the culvert had put a very considerable pressure on it, a pressure sufficient to force off the covers from both manholes. It was through the open manholes that the soil was enabled to enter the culvert.

The pressure of water in the water main would be approximately 90 lbs. per square inch, and the amount of damage done to the roadway and footpath was very considerable, a great deal of soil being washed away into the basements of the houses.

The culvert was found to be uninjured, and after being thoroughly cleaned out was covered in again, and the supply re-established by about 6 p.m.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

22,651A. "Improvements in fuses and exploders." A. W. Marshall. March 22nd. (Date claimed under Patents Rule 19, December 12th, 1900.)

5,628. "Self-fastening rail bond for electrical connection of rail." J. W. Sheperdson. March 18th.

5,662. "Improvements in electric heaters." A. R. Leask and P. M. Bellis. March 18th.

5,700. "Improvements in or relating to electric clocks." J. Poschl and J. M. Gautsch. March 18th. (Complete.)

5,713. "Improvements in electrical switches." H. Lomax, R. Lomax and J. Tomlinson. March 19th.

5,714. "Improvements in hand fed arc lamps." G. Smith and H. H. Hall. March 19th.

5,719. "Self-lubrication (without oil) of the swivelling spindles or forks connected with 'trolley heads,' used on the overhead trolley system of electric tramway cars." T. B. Birkby and F. E. Birkby. March 19th.

5,728. "Improvements in apparatus for changing illuminated advertisements, and for other purposes, the switch connected therewith being also applicable for electric lighting generally." P. Mushet and C. P. Eggar. March 19th.

5,754. "Improvements in mounting incandescence electric lamps." E. de Pass. (La Societe Anonyme Pour la Transmission de la Force, par l'Electricité, France.) March 19th.

5,764. "Improvements in obtaining zinc by electrolysis and apparatus for that purpose." L. Mond. March 19th.

5,766. "Improvements in the working and controlling of electrically-driven cars." Siemens Bros. & Co., Ltd., A. Siemens, and A. M. Duke. March 19th.

5,786. "Improvements relating to telephonic apparatus, comprising compensation counters or meters." H. Eichwede. March 19th (Complete.)

5,808. "An improved single or duplex electric clockwork switch for turning on and off electric light, every half minute or for longer or shorter period, for illuminating or advertising purposes." T. J. Phipps. March 19th.

5,903. "Improvements in ships' telegraphs for gunnery purposes." S. Evershed and Evershed & Vignoles, Ltd. March 20th.

5,906. "Improvements in electrical heating apparatus." R. W. Boyd. March 20th. (Complete.)

5,921. "Improvements in lifeguards for electric tramcars or the like." D. Newton. March 21st.

5,952. "An improved watertight cover for electric cut-outs, switches, joint-boxes, and the like." H. Hirst and T. H. Bacon. March 21st.

5,954. "Improvements in armatures for dynamo-electric machines and the like and in the manufacture of the same." J. Matthews and W. Davies. March 21st.

5,964. "Improvements in or relating to electric railway signals." A. J. Boult. (J. D. Price and W. H. Council, United States.) March 21st. (Complete.)

5,975. "Improvements in carriers for glow lamps." C. Colsman and A. Colsman. March 21st. (Complete.)

5,985. "Improvements in and relating to current collectors for electric railways on the overhead system." A. Reinecke and A. Jost. March 21st. (Complete.)

5,986. "Improved armature core for electric generators." G. Koppelmann. March 21st. (Complete.)

5,987. "Improvements in carrying telephone and telegraph wires across streets and protecting the trolley wires or overhead wires of electrical tramways therefrom in case of breakage." A. W. Bennis. March 21st.

6,004. "Improvements in means or apparatus for driving dynamos on railway and other vehicles from the axles thereof and for connecting such dynamos and batteries to lighting, heating or other circuits on such vehicles." F. J. Beaumont and W. M. Still. March 21st.

6,010. "An automatic electric cut-off." E. P. Appleyard. March 22nd.

6,041. "Improved contrivance for concealing slack wires on lifts, arc lamps, wall plugs, ceiling pendants, and the like." W. Brown. March 22nd.

6,042. "Improvements in printing telegraphs." L. Kamm. March 23nd.

6,043. "Trolley conductor insulated fitting for electric tramways and railways." F. G. Kleinsteuber. March 22nd.

6,070. "Improvements in apparatus for the generation and electrolytic application of electric currents." F. E. Elmore. (Partly by J. O. S. Elmore, India.) March 22nd.

6,085. "Improved terminal for electric wires." E. D. Billing and A. Dunhill. March 22nd.

6,096. "Improvements in and relating to electric arc lamps." L. B. Codd. March 23rd.

6,097. "Improvements in storing up waste power, by balance weight, for enabling electric and other tramcars or vehicles to travel up and down very steep inclines with perfect safety." T. Greenwood. March 23rd.

6,102. "Improvements in anodes." A. F. Harris. March 23rd.

6,104. "Improvements in or connected with the trolley wheels used in overhead electrical traction." R. L. Ross and R. Bridge. March 23rd.

6,107. "Improvements in electrical measuring instruments." A. C. Heap and W. O. Smith. March 23rd.

6,113. "An electric fog and danger railway signal." H. J. Everatt and A. Tewson. March 23rd.

6,125. "Improvements in incandescent electric lampholders." G. H. Parr. March 23rd.

6,127. "Improvements in or relating to starting and controlling electromotors." W. S. Boult. March 23rd.

6,161. "Method of and apparatus for controlling single-phase alternate current motors." Siemens Bros. & Co., Ltd., and F. Lydall. March 23rd.

6,164. "Improvements in and relating to accumulator plates." E. Franke. March 23rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

9,414. "Improvements in controlling electric motors and apparatus for that purpose." H. Leitner. Dated May 4th, 1899. Relates to means for controlling electric motors, particularly such as are employed for propelling vehicles, comprising a main battery or generator, a smaller battery for exciting the motor fields, and a controlling switch for varying the connections of the motors and the batteries. The invention is described with reference to diagrams and is too complicated for abridgment. 2 claims.

9,434. "Improvements in electric arc lamps." A. G. Stockwell. Dated May 4th, 1899. Arc lamps.—The frame consists of a shackle, a top piece having lateral arms, two side bolts, a table, a plate, two side rods, and a yoke. The lower carbon holder is carried on the yoke, but insulated therefrom, and is connected by insulated wire to a terminal on an arm of the top piece. The upper carbon is carried by a rod, which slides in the table and plate, and passes between two grooved clutch blocks pivoted in a lever. The left-hand end of the lever is movable on a vertical rod above a stop. The other end of the lever is linked to a regulating lever which carries cores in series and shunt solenoid held between the table and top piece and in a dash-pot. A globe is carried by a disc attached to two rods and forks which slide in holes in the ends of the yoke, and on the side rods. The disc and globe are supported in working position by a handle with a bayonet joint engaging a socket on the yoke and a retaining spring. In a modification the lower carbon holder is connected by a cord passed over a pulley to the upper holder, which is controlled as described above. 3 claims.

9,436. "Improvements in electric telegraphic apparatus." E. Cantano. Dated May 4th, 1899. (Date under International Convention, January 12th, 1899.) Transmitting and receiving apparatus for Morse signalling is provided with a shunt dynamo or magneto-generator capable of providing current of electromotive force corresponding to the length and resistance of the line, and at the same time to run at an approximately uniform rate. The shunt dynamo has an armature preferably without iron, and in either form the armature is arranged to be axially adjusted in the field. The armature is attached by gearing to a weight motor, the weights of which can be altered to give a uniform speed whatever the position of the armature. A starting or stopping handle is also provided. 5 claims.

9,437. "Improvements in electric telegraphic apparatus." E. Cantano. Dated May 4th, 1899. (Date under International Convention, April 13th, 1899.) Relates to improvements on the invention described in Specification No. 9,436, A.D. 1899, in which magneto-generators and shunt dynamos are employed to give varying electro-motive force with constant speed. The intensity of the field is varied by means of an adjustable magnetic shunt bar. The gearing is provided with a starting and stopping milled head. 2 claims.

9,456. "Improvements in or relating to electric storage or secondary batteries." J. T. Niblett and M. Sutherland. Dated May 5th, 1899. Relates to electrodes in which the active material or materials to be rendered active is pasted on to conducting-supports, and is held in place and prevented from becoming disintegrated by porous non-conducting supports or separators. The invention consists in pasting the active material or materials to be rendered active partly on to the conducting supports, and partly on to the non-conducting supports, and then uniting the material on adjacent conducting and non-conducting supports by pressure, cement, or allowing them to agglomerate together during the forming process. The surfaces of the supports which hold the material may be flat, or may be provided with ribs, &c., to increase the grip on the material,

and the external surface of the non-conducting supports may be provided with grooves, &c., to facilitate the circulation of the electrolyte. The grooves, &c., in adjacent plates, preferably run at right angles to each other. 2 claims.

9,512. "Improvements in voltaic batteries." C. D. Abel. Dated May 5th, 1899. Relates to batteries in which depolarisation is effected by hot air, and consists in leading the hot air into the electrode to be depolarised. The positive electrode is made of two sheets of copper gauze, or copper finely perforated and placed at a little distance apart, and soldered together at their edges to form a casing, into the lower part of which is led an air pipe, the part of which within the casing is extended along the base and perforated to distribute the air uniformly. On the outside of the casing on each side is fixed a sheet of large meshed copper gauze, which forms part of the electrode and is held in place by copper clips. The negative electrode consists of two zinc plates, one on each side of the casing. Each plate is covered with parchment paper and a thick layer of asbestos, which is bent around the lower edge of the plate, and the two folds are fastened together at the top by celluloid clips. The air pipes lead to a pipe which is connected to a pump by which air is at intervals pumped into the electrode; the strokes of the pump cause the electrodes to vibrate, and this vibration aids the depolarisation. Other metals than those named may be employed. The electrolyte is fed from a tank flows through the battery and is run off through a pipe into a tank whence it may be drawn off to be regenerated and to be used again. 1 claim.

9,518. "Improvements in automatic telephone switches." V. Veysy. Dated May 5th, 1899. Relates to improvements in the subscriber's apparatus employed in the automatic exchange system described in Specification No. 18,912, A.D. 1896. A contact drum has two caps operated by a crank to send the releasing currents and the currents for selecting the group of the subscriber wanted. Two brushes are electrically connected and two other brushes are connected to the opposite poles of a split battery, the cap has two projecting contacts situated between the ends of a series of ten contacts on the cap. The selector for operating the exchange carriage is set by hand, and is in the form of three interacting counter rings driven when returning to zero by a clockwork controlled by an escapement and the pivoted armature lever of the magnet. The circuit of the magnet is controlled by the line relay. The number discs are provided with studs closing a circuit simultaneously when two of the wheels have returned to zero and the third disc is making its last movement to zero. This circuit stops the exchange selecting carriage. A rotating double contact switch lever is mounted on the door. When the selection is complete a double clip on the telephone wire is hooked on to the clips cutting out the selecting device and putting the telephones to line. 5 claims.

9,522. "Improvements relating to the distribution of electric currents." B. G. Lamme. Dated May 5th, 1899. (Dated under International Convention, October 6th, 1898.) Relates to the regulation of electromotive force in constant potential systems by automatically adjusting the excitation of the field magnet of the generator. Variations in the speed of the motor, due to variations in the distributing system, vary the electromotive force of the field coil. The motor generator may be replaced by a rotary transformer. 3 claims.

9,631. "Improvements in or connected with electric conductors and anodes for electrolytic and similar purposes." The General Electrolytic Parent Company, Limited. (L. Hargreaves and W. Stubbs.) Dated May 8th, 1899. Electrodes. Between the electrolyte and the electric conductors there is placed oil or its equivalent, or an oil-saturated material, whereby the junctions of the conductors with the carbon anodes are protected against the action of the current or of the electrolyte. The oil is contained in special casings or receptacles. The connection between the anodes and the conductors may be by means of carbon blocks passing through non-conducting casings, or by specially-arranged bolts. The anodes at or near their junctions with the conductors may be saturated with oil or its equivalent. The double metallic conductor is surrounded by a cement or other non-conducting casing, the space being filled with oil or other liquid or solution not miscible with the electrolyte. Two carbon anodes are connected together by nuts and bolts covered by insulating material. The bolts and nuts force the anodes against carbon blocks which may have soft metal washers and the latter against the conductor. Several modifications of the arrangement are described. In cells worked above ordinary temperatures the oil is preferably one which is semi-solid, and only becomes fluid at the normal working temperature. Such an oil is resin oil with a quantity of resin dissolved therein. The oil should be as nearly as possible of the same specific gravity as the electrolyte. 5 claims.

9,750. "Improvements in printing telegraphs." B. J. B. Mills. (J. R. Tucker and C. C. Henekley.) Dated May 9th, 1899. The apparatus consists of electro-mechanical arrangements by which the keys of a type-writer can be employed to operate a corresponding number of relays capable of closing a number of electric circuits in pre-arranged permutations. These electric impulses are transmitted in sequence to line, and operate at the receiving-end selective mechanism by which the impulses are sorted out to corresponding number of electro-magnets. These electro-magnets combine the elements of the permutations, and by means of further magnets operate type-writer levers which reproduce the predetermined signals. 14 claims.

9,781. "Improvements in apparatus for receiving 'Hertz' electric undulation or waves." E. Ducretet. Dated May 9th, 1899. A coherer for Hertzian wave telegraphy is formed of an insulating tube, capped at each end, and having close-fitting metal rods, one or both of which may be adjustable. The ends of the rods are formed of non-oxidisable or amalgamated metal, and the space between contains metal filings. A fixed central rod with two end rods forms two granule cells in a modified form. The coherer may be arranged in the relay or receiver circuit with variable condensers, and with single-pole or other induction coils. 4 claims.

10,133. "Improvements in systems of control for electrically-propelled vehicles." The British Thomson-Houston Company, Limited. (W. B. Potter.) Dated May 13th, 1899. Relates to systems of control for electrically-propelled vehicles where a number of cars are or may be united to form a train, each car having a motor or motors and a controller, and the train having one or more master controllers for all the motors. The separate controllers are driven step by step by pilot motors controlled by the master controller. Switches are also provided for controlling emergency brakes. 16 claims.

10,134. "Improvements in controlling devices for electric motors." The British Thomson-Houston Company, Limited. (F. E. Case.) Dated May 13th, 1899. Motor controllers are fitted with additional contacts so that the motors may be connected up as generators for operating the brakes, a single set of resistances serving for regulation in each case. In the form of controller described, the regulating and reversing switches are mounted as usual, and the braking switch is in line with the reversing switch but operated mechanically from the regulating switch. 9 claims.

10,163. "Improvements in electric circuit breakers." H. H. Lake. (W. M. Scott.) Dated May 13th, 1899. The main contact of an automatic circuit-breaker is mounted to slide on bars, and to it is pivoted a rod forming one part of the toggle operating mechanism. The other member consists of the hand-lever carrying a pin working in a slot in the member. The hand-lever also carries a roller engaging with a lever of a supplemental shunt switch. This supplemental switch comprises a bridge-piece engaging with a pair of contacts and pivoted carbon contacts arranged in pairs. Movement of the handle first closes the shunt switch, the roller running over the cam face, and then the main switch. The switch is held closed by a latch engaging a pin on the hand-lever. The switch is opened by the core of the over-load magnet operating the latch. Spring pistons are arranged to force back the levers. The contact is made of curved laminæ with the outer ends somewhat apart. 8 claims.

10,164. "Improvements in interrupters for electric currents." Dr. H. T. Simon. Dated May 13th, 1899. Interrupters for induction coils, a liquid resistance being employed. In the form described, the lead vessel forms one electrode, and a plate fitted within a glass tube, forms the second. A small perforation is provided in the glass tube, and the vessel is filled with dilute sulphuric acid or the like. In another form the vessel is of non-conducting material, and is divided into two compartments by a partition having a number of perforations. By closing certain of the perforations, the frequency of the interruptions can be varied. In a modification two vessels are shown connected by a U-tube, an air bubble being left in the tube. The electrodes and solution are adapted to one another, *e.g.*, with copper electrodes, a solution of 'copper sulphate' would form the liquid resistance. 4 claims.

10,183. "A removable combination magnet and coil for electric generators and motors." C. H. Cutting and G. H. Cutting. Dated May 15th, 1899. Relates to field-magnets. Consists in making the field magnets readily detachable from the frame or yoke of the machine. The magnet is cast in one piece with flanges which are secured by screws to the yoke. The coil is wound directly on the core and is removable with it. The magnets may be withdrawn in a direction at right angles to the shaft or parallel thereto. In the latter case the yoke is divided circumferentially, and one part is removed before withdrawing the magnets. 4 claims.

10,238. "Improvements in coin-operated mechanism specially applicable for electric and other meters." E. Du Bois and The Mutual Electric Trust, Limited. Dated May 15th, 1899. Electricity supplying, gas meters, liquid meters. The invention is described in connection with the supply of electricity. The circuit is completed when a rocker is tilted, so that a fork which it bears dips into mercury cups and a detent hook retains it. During the expiry of a given time or the delivery of a certain amount of current, a cam makes a lever, having a click at the operating end, take a position under a nose on the detent hook, and finally lets it recover its initial position by gravity, and in so doing disengage the detent hook from the rocker. Coin action: The coin sets the rocker under the detent hook by rolling in the shoot over its intruding limb. A roller on the other limb of the rocker prevents a second coin from passing till the rocker is again free from the detent.

10,246. "Improvements in portable telephones." L. M. Ericsson. Dated May 15th, 1899. The receiver and transmitter are mounted on slides respectively. The slides telescope into a central portion or handle provided with a switch. The receiver slide is tubular, and contains the coiled wires forming the connections. The necessary contacts are arranged in a recess in the back of the transmitter. A hinged flap acts as a reflector for the transmitter.

10,301 "Improvements in or relating to overhead systems for electrical transmission of energy." W. Routledge. Dated May 16th, 1899. Conductors arranged in sections have those sections connected together by pivoted angle pieces contacting together by blades. The pieces are pivoted to insulating plates connected to the bracket. The trolley wheel is provided with an extra conducting slip. 1 claim.

10,406. "Improvements in wireless telegraphy." L. B. Miller. Dated May 17th, 1899. Relates to wireless telegraphy. The coherer is mounted on the armature of a decohering magnet, the contact being in the coherer circuit and the coils of the magnet in the relay circuit. The contacts may be shunted by self-inductances, and the receiver coils may be in parallel with the decoherer. The coherer is constructed with two electrodes separated by insulating material, and has wires fused into one end of the glass tube. The electrodes may be side by side, or may be concentric; the outer tubular electrode is shown closed by a screw cap, and the tube is exhausted. The granules are preferably non-magnetic. 3 claims.

10,768. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (R. Fleming.) Dated May 23rd, 1899. Arc lamps, especially for use in series on constant alternating current circuits. The frame of the lamp consists of a head with arms carrying two tubes, which are connected by a yoke supporting the lower carbon holder and an arc-enclosing globe, and which receive rods supporting a lower yoke and an outer globe. Two plates connected by a central hollow part fit between the tubes, and are supported by four rods attached to the head by screws. Two pairs of vertical solenoids have their end plates bored to fit on pairs of these rods, and are held at proper heights by spacing tubes placed on the rods. The upper carbon is carried by a clutch on a central tube which slides in detachable guides on the plate and the head, and is supported by springs. The spring is mounted on a clamp on the tube, and the plate spring on an H-shaped core within the solenoids. The lower solenoids are connected directly between the terminals of the lamp, and are provided with a fixed core extending about one-third through them; this construction and the varying reactance of the solenoids as the core moves, are stated to give a fairly uniform pull on the core in any position. A straight armature is fixed above the upper solenoids which are in series with the carbons. The series solenoids may be replaced by a spring and the frame shortened. The clamp carries a dash-pot, the piston of which is clamped on a tube. The core carries a contact above another clamped on a tube; these contacts are connected with the lamp terminals through a resistance, and act as a cut-out. A series reactance coil, not shown, is wound on a circular laminated iron core, containing a short air-gap, and surrounding the upper part of the lamp; the core rests on springs surrounding vertical guide-rods carried by the head to avoid production of noise. 17 claims.

10,839. "Improvements in automatic electric cut-out devices for electric cooking apparatus." F. W. Schindler. Dated May 24th, 1899. Cut-out device for breaking the circuit when the cooking appliance becomes overheated. In the arrangement the connecting device is soldered to the vessel by soft solder, which melts when the vessel is working empty. The connecting piece then falls away and breaks the circuit between the ring connected to the heater and the disc or nut to which one of the conductors is clamped. 1 claim.

10,860. "Improvements in or relating to electric railways and tramways worked on a mixed power system." Dr. E. Andreas. Dated May 24th, 1899. Electric railways and tramways worked on a mixed power system with accumulators and line conductors. To prevent unintended discharge of the accumulators or to cut them out if the line potential is too high, a resistance and cell are placed in the main charging circuit, which can be broken by the electro-magnetic cut-out in the shunt circuit. The cell is of the type which allows current to flow in one direction only. Reference is made to Specification No 17,507, A.D. 1898. 1 claim.

10,416. "Improvements in incandescence electric lamps." Dr. W. Mengarini. Dated May 17th, 1899. Incandescent lamps.—Incandescence bodies which conduct only after preliminary heating by adjacent wires, are connected in series and parallel with fixed resistances to form a balanced network, in which the heating wires form transverse bridging connections, so that when the incandescence bodies have been heated and are conveying their proper currents, no differences of potential exist at the end of the heating wires, and these receive no current, but when the incandescence bodies convey less than their proper currents, current passes through the heaters. With alternating currents the resistances may be inductive, and the incandescence bodies may be supplied from transformers, the primary coils of which form parts of the resistant net, and which may be placed in the base of the lamp itself. 1 claim.

10,468. "Improvements in party telephone line systems." W. Aitken. Dated May 18th, 1899. Direct-call party lines, in which the subscribers work in pairs are arranged with means for locking all the other instruments, so that there can be no interference. The subscribers have oppositely-relays bridged across the calling-keys, and the subscriber has a differentially-wound coil connected at its middle point to the calling-key, the back contact of which is connected to the relay. The local circuits of the relays include the indicator and bell in parallel; a branch circuit from the relay also includes the locking-magnet, the function of which is to prevent a second call from being made while the line is in use. The locking-circuit is broken by the telephone lever rising when two subscribers are in communication. 2 claims.

10,383. "Improvements in or relating to electro-mechanical impulse devices applicable to clocks and for other purposes." H. Campiche. Dated May 17th, 1899. Relates to electrical apparatus for driving or giving an impulse to clocks or other apparatus. Consists of an electro-magnet or pair of magnets, the armature of which is carried by a pivotted lever. At the same point is also pivotted a lever, to the free end of which is pivotted a lever carrying the arms for operating a pendulum or other object. A spring is fixed at one end to the second lever, its free end engaging with a projection on the first lever. When the magnet is energised the armature is attracted, and with it the first lever. The second lever then moves under the action of the spring without shock. The free end of the third lever strikes a stop and the arm has an increased angular movement. The parts are restored by springs or weights when the current ceases. 3 claims.

10,699. "Improvements in and connected with street lamp-posts, electric light standards and the like." W. Jones. Dated May 23rd, 1899. Lamp-posts for electric and other lighting are fitted with fire alarms and hydrants. The hydrants are provided with main and bye-pass cocks sunk in the ground near the base of the post. A tap may be fitted on one of the hydrant nozzles and the hydrant may be used for watering the roads. 5 claims.